

**INFORMATION NEEDS ALONG THE JOURNEY CHAIN:
USERS' PERSPECTIVE ABOUT BUS SYSTEM.**

by

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I, Martha Mendes Caiafa confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

ABSTRACT

Buses constitute the main public transport mode in most cities of the world. Accessible Bus Systems are defined as systems that are easy to use. However accessible the infrastructure may be, it is unlikely to provide access if people cannot know about it. Therefore it is essential to have comprehensive and accessible information systems which describe the bus systems during all the stages of the journey.

There is a widespread understanding amongst researchers that Information Systems can increase the efficiency of the system and that they should be oriented to meet bus users' needs. However, existing information systems largely ignore the user's point of view, in special the requirement of the disabled users. This thesis describes a methodology developed to investigate the problem of using information during a journey by bus in real conditions taking into account the (un)familiarity of the area in study and the individual's previous knowledge of information system.

Two main aspects are identified — the “Required Environment Capability” (the physical, social and psychological environment conditions) and the “Individual Capability Provided” (the individual ability in physical, sensorial and cognitive terms) to plan and execute a journey by bus in an unfamiliar environment. Because of the multidisciplinary aspect of the theme this study uses approaches from different fields of research to construct a methodology to understand individual information use. Based on the principles of Single Case Analysis adapted by adding the concept of the Capabilities Model (CM) (which explores interactions between individual and environment), the combined SCA/CM approach was employed to construct the INFOChain experiment. A set of information pieces were developed for the experiment, delivering Accessibility-Issues (AI-type) information in order to help older people to plan and execute different bus journeys in two different cities: London/UK and Brasilia/BR.

General results have shown that although the AI-Type of information is considered important by older people, it needs more than simple expositions to actually take advantages of the information and be able to help disabled users.

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To Pedro, my son and
to Euclydes, my father

1 INTRODUCTION

This chapter is intended mainly to justify and put into context the topic of this thesis: older user's information needs for bus systems. Additionally, it describes how the work is structured.

1.1 CONTEXT

Banister and Bowling (2004, p: 114) stressed that “it is important to take the wider view than conventionally used in transport analysis to identify the key concerns of the elderly, not just in terms of what they choose to do (active involvement - the transport elements), but also in terms of their integration in their local community and neighbourhood” (the out-of-home mobility). Out-door-mobility is a term, used by researchers in Environment Gerontology to mean as a “complex phenomenon characterised as a comprehensive construct” (Mollenkopf *et al.* 2004, p: 46), involving: older adult personal abilities and resources (individual capabilities) and aspects of their physical and social environment (environment capabilities). Mollenkopf (p: 45) also highlighted that “support and stimulation for enhancing out-of-home mobility in later life”, highly relevant for ‘good life’ for ageing citizens (Lawton, 1983), involves measures in transport policy and social policy.

The current proportion of elderly people in the population in Europe is 17% and the estimate for 2030 is 35% (OECD, 1998). Metz (2000, p:149) pointed out that “the projected population of the United Kingdom shows the number of people aged 75 and over doubling by the middle of this century - from four million now to eight million by 2050 - while the overall number of inhabitants is little changed (Office for National Statistics, 1999a)”. In Brazil this number varies around 6% (16.4 million of people over 60, IBGE (2009)) but “by the year 2025 they will represent the 6th largest elderly population in the world”, Ramos (1987, p: 223). Ramos stressed that the elderly have been the fastest growing age-group in Brazil since 1940. In fact, from 1980 up to the year 2000, the over-60s increased by 107% whereas the under 15s increased by only 14%. Ramos also compared the rates of growth for the elderly populations in England and Brazil, the tendency is to have a decreasing rate of growth in England (230%

between 1900-1960 and 80% between 1960-2025) and an increasing rate of growth in Brazil (497% and 917% respectively).

According to research of a large-scale survey carried out, as part of the British Office for National Statistics (ONS) Omnibus Surveys on those aged 65 years and over, Banister and Bowling, (2004) concluded that ‘Quality of life (QoL)’ declines with age, being patterns of mobility, a key element. As stressed before, transport plays an important role in older people’s quality of life, particularly in relation to access to local services and facilities, and in engaging in social activities. According to the research made by DETR (2001), in the UK, although the private car is the preferred mode of the elderly, public transport service appears as another mode to be considered, particularly for women, as long as it is safe, reliable, accessible and affordable (Help the Aged, 2002).

Within the public transport system, bus systems are the main mode of public transport in cities all over the world. “They are highly adaptable and can be provided in virtually any environment, under a variety of different operational, economic and regulatory regimes. They cause less environmental impact and accidental cost when compared with the other technologies.” (Silva, 2001, p: 17)

In the United Kingdom, for instance, with a total population of approximately 60.9 million (National Statistics, 2009), more than 4 billion trips are made by bus per year, representing two thirds of all public transport trips (DETR, 1999). In the area of Greater London, with a population of approximately 7.6 million, 3.3 million trips (TfL, 2007) are made each day on 700 bus routes, 8,200 buses and 19,000 bus stops (TfL, 2009).

In Brazil, and its 191.7 million inhabitants (IBGE, 2009) more than 14.4 billion trips are made by bus per year (ANTP, 2007). In Brasília/DF, with 2.33 million inhabitants almost 470,035 trips are made each month (14,470,623 passenger/month, DFTRANS 2008 or around 700,000 passenger/day) on 752 service routes, with 2,691 vehicles (DFTRANS, 2008) and approximately 3,376 bus stops (DMTU, 2002b). In many cases buses are the only way to do an activity. In worse situations even that is not the case: According to the left wing movement estimations (“Movimento Passe Livre”) supported by Universities research (UFMT - Universidade Federal de Mato Grosso and UFRJ - Universidade Federal do Rio de Janeiro) and Statistical Institute studies (ITRANS -

Instituto de Desenvolvimento e Informação em Transporte, IPEA - Instituto de Pesquisa Econômica Aplicada and NTU - Associação Nacional das Empresas de Transportes Urbanos)) around 32% to 35% of people (37 to 41 million) in Brazil are excluded from public transport system either because they cannot afford tickets or because the places where they live are not served by public transport.

Another issue that can impact on the quality of life of excluded people and older people is the accessibility to the bus system. Accessible bus systems are defined as systems that are easy to use: easy to find; easy to reach; easy to understand and easy to use. The degree of accessibility, however, depends on a number of relationships: vehicle/operators, service/operators and local authority, information/operators and local authority, bus stop location/local authority, bus stop layout/local authority, access to service/local authority and operators.

From the user's point of view the same factors can have an impact on the effective use of a bus system as is illustrated in Table 1.1.

Table 1.1 – Factors of an Accessible Bus System from the User's perspective

Components of a Fully Accessible Bus System	Description
Accessible Vehicle adopted for wheelchairs and pushchairs.	Vehicle (space inside vehicle) must be accessible (free of steps).
Accessible Bus Stop Layout and Low Floor Buses	i. Access to vehicle needs to be guaranteed by minimum gaps; ii. Access from vehicle to bus stop platform must be guaranteed by minimum gaps.
Unobstructed Environment	i. Access to bus stop needs to be free of barriers; ii. Access to (public) destination must be free of barriers.
Accessible Information System	Information needs to be available along the whole journey, including the walking stages.
Accessible On Board Information	Information inside bus must be provided so users can follow the journey and decide where to get off.
Information about Interchange/Integration	Information about connections with other modes

A system can be considered fully accessible if it can be easily used by all users. Most accessible systems are actually only partially accessible, having vehicle adaptation with no other complementary investment, such as infrastructure adaptation or information provision.

From the above it can be noticed that improvements in vehicle design (generally the first and the main emphasis in many implementations of the 'Accessible Bus System')

is just part of the problem. It might be the easiest to tackle but it is unfortunately the only portion achieved by most examples of bus systems. There is a huge pressure on operators to adapt the vehicle to the new rules of design for disabled people. This is not without reason because the older vehicle designs have excluded many disabled people (who are often on low income levels) for many years. However, an adapted vehicle is not ‘the whole solution’ for an Accessible Bus System. Massive investments ought to be applied to the repair of footways, buildings, bus networks and bus stop layouts until everybody can have access to basic activities, such as going to a hospital, to a library or to attend a school.

However accessible the infrastructure may be, it is unlikely to provide access if people cannot know about it. Awareness of the transport system (bus systems) is important to maintain independent life in old age. Therefore it is essential to have a comprehensive and accessible information system which describes the bus system. The importance of an Information System to the enhancement of a bus system as a form of sustainable development is crucial. Whether to guarantee the only mode of movement for many people or to reduce the use of private vehicles, a good quality bus information system is essential. This thesis proposes a methodology to investigate the use of bus system information for a particular group of users: old people) and applies it to two different urban environments: London/UK and Brasília/BR.

1.2 AIMS AND OBJECTIVES

Improvements in information systems do not only require improvements in quantity and quality of information. For the development of an accessible information system it is absolutely necessary to understand how a user selects, processes and uses information in order to plan and complete a journey that will allow him/her to execute a desired activity. If the information system is complete and accessible (meaning: that it delivers information along the whole journey for all kinds of people) the user will be able to plan a journey and execute it in the real world with some degree of control. The working hypothesis is that: Information about accessibility issues can help (older) people to construct a better plan and consequently successfully complete the journey.

The starting point of this research is the assumption that, in order to assess properly the impacts of information on a user's behaviour, it is necessary to understand how users use the information provided. So, the aim of this study is to understand the ability to use available information. The word 'use' in the context of this study is comprehensive: it implies that the user will be able to select the information, process it to construct his/her plan and to execute the plan to do an activity. In this sense, the main objective of this study is to develop an instrument, which can represent reliably the behaviour of users in planning and executing a journey by bus in unfamiliar urban environments. The knowledge derived by the study could be used to help improve the design (from content to dissemination) of important elements for more accessible information systems and to improve individual awareness about aspects involved in the use of bus system (i.e.: personal training). To achieve this it is necessary to identify users' specific requirements in relation to information, particularly for the target public (users over 65 years of age) and to evaluate the current level of information provided.

Information Systems for the Urban Bus Sector offer different kinds/levels of information along the journey. There are systems that provide good quality information (London case) and others that offer very shallow type of information (Brasilia case). Depending on the level of information provided to a specific user and the level of information they can process, the task ("do a journey" by bus in an unfamiliar environment), can, in principle, be possible (and easier) if the system is accessible and the user knows how to use it. As a consequence of the aim and assumption outlined above, the research question is to understand how (older) people use information to make a journey by bus. The following objectives to support this are:

- i. To understand general human information processing;
- ii. To understand the information structures applied to bus systems (e.g.: pre-trip, in-trip);
- iii. To understand how an individual uses different types of information provision.

An extensive review of literature was conducted to build a strong background to conduct the research. Four areas of concern are investigated in this review:

- i. Theoretical models to understand the use of information to compose a plan and do a journey by bus (spatial orientation) and the issues related to older people;
- ii. Transport Information Systems and the issues related to older people;

- iii. The concepts of Accessibility, Capability, Journey Chain, Accessible Information System and Information Chain and the issues related to older people;
- iv. Techniques to capture users' behaviour in a laboratory and real situations and the issues related to older people.

1.3 STRUCTURE

This thesis is divided into 10 chapters. Figure 1.1 gives the central idea developed in each chapter and shows their relations.

Chapter 2 considers the basic phenomenon required to understand the problem: it describes the concept of Journey Chain and the importance of the flow of information along it. It ends presenting how the phenomenon is going to be studied: The combined application of Single Case Analysis and Capability Model (SCA/CM). In Chapter 3, the literature relevant to cognitive processes and spatial knowledge is discussed and a conceptual schema to support the experiment is presented (INFOChain Theoretical Schema). Information Systems are discussed in Chapter 4 and a taxonomy which will be used to analyse how the phenomenon is going to be studied (INFOChain Taxonomy).

Chapter 5 and 6 set out the experimental methodology (INFOChain Experiments), divided in two main parts: Capture individual and environment capabilities, and set up an experiment to observe individual planning and execution of a journey by bus in a real and unfamiliar environment, respectively.

The experiments were undertaken in two locations – London and Brasília. These are described and their results given in Chapters 7 and 8 respectively. Chapter 9 discusses the findings from the experiments described in Chapters 7 and 8 and offers some comparative findings. Conclusions are drawn in Chapter 10 together with some recommendations for further research.

Annexes A1 (part A and B) presents the experiment environments and A2 presents information features. A3 contains the individual data captured during experiments (plan document, journey representation before and after real journey exercise) and A4 provides a glossary of terms used throughout the text.

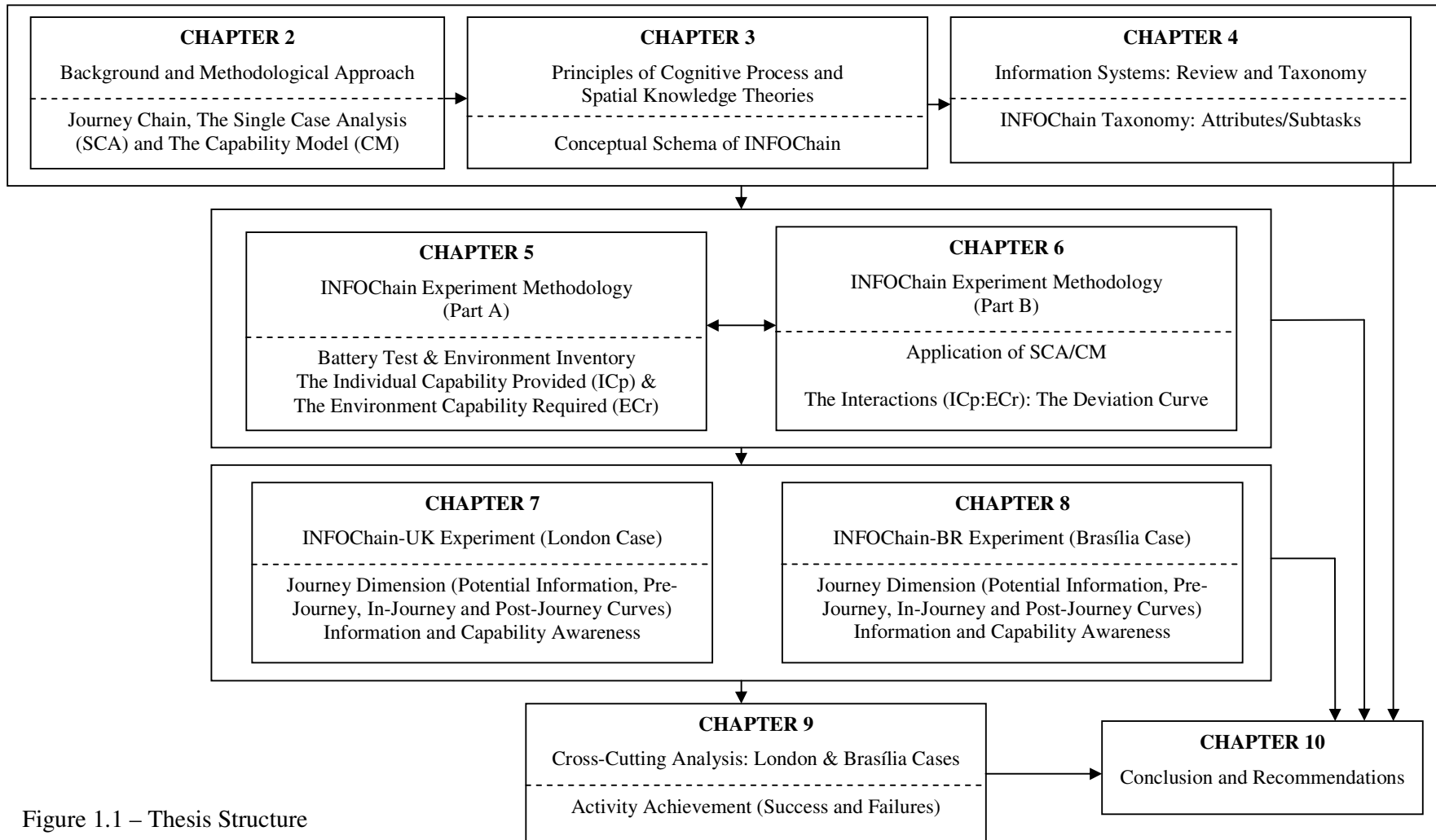


Figure 1.1 – Thesis Structure

2 BACKGROUND AND METHODOLOGICAL APPROACH

The aim of this chapter is to present information system developments to answer user's needs for public transport and aspects involved in users' behaviour when doing a journey by bus.

The remainder of this chapter details aspects of the phenomenon as studied in this research, and the methodological approaches employed in their understanding. Section 2.1 presents an overview of research and technological development related to information system in Europe using London as an example and in Brazil taking Brasília as an example. The nature of the phenomena in the study is presented in Section 2.2 in which the concepts of Journey Chain and Information Chain are introduced. Section 2.3 brings methodological considerations about the research theme and how the problem is approached. Section 2.4 and 2.5 describe the principles that are used to compose the methodology of this study: The Capability Model and The Concept of Awareness. Section 2.6 describes aspects related to the use of information and the public target of this study and its specifics. Finally, Section 2.7 summarises the conclusions of this chapter.

2.1 RESEARCH DEVELOPMENT IN INFORMATION SYSTEM FOR PUBLIC TRANSPORT

The initial studies of information systems for public transport in Europe are products of research to implement the principles of telematics¹, initiated in the 1980s by the Commission of the Europe Communities (CEC) - Directorate General for Energy and Transport and their different framework programmes and projects. The general aim was to reduce energy consumption (reducing congestion and pollution) and one possibility is via improving public transport systems, providing an Integrated Road Transport Environment (IRTE) covering all forms of road transport. The aims of the frameworks were modified during the decades as described on the following paragraphs.

¹ Telematics: application of information and communications technology to transport problems (For a complete review relevant to public transport see Wilkinson et al. 1998)

In the DRIVE I programme, Dedicated Road Infrastructure for Vehicle Safety in Europe, (1988-1991), and DRIVE II (1990-1994) a number of projects aimed to establish standards and specification for systems and to evaluate schemes in public transport information systems. Among them, three DRIVE I projects (PROMISE - Prometheus CED 10 Mobile and Portable Information System in Europe, INFOBUS and CASSIOPE - Computer Aided System for Scheduling Information and Operation of Public Transport in Europe) and five DRIVE II projects (SCOPE/ROMANSE project in Southampton/UK, assessed Advanced Transport Telematics (ATT), EUROBUS - continuation of CASSIOPE project, QUARTET - Quadrilateral Advanced Research on Telematics for Environment and Transport, and ASTRA) focused on public transport information systems.

DRIVE I projects concentrated on exploratory actions. The projects related in DRIVE I identified passenger information as a key element for public transport systems. DRIVE II projects' focus was the implementation of Advanced Transport Telematics (ATT). Of particular interest to the present study was the conclusion from the STOPWATCH project not only because it was conducted in UK but also because it revealed important points about the acceptance and use of the bus information system. STOPWATCH concluded that although the technological device was accepted and considered useful at the time there seems to have been an overestimation of the impact on the trip making patterns of bus users by a factor of three (Nijkamp, Pepping and Banister, 1996).

INFOPOLIS 2 (1988-2000) was another project of the European Commission Telematics Applications Programme, especially dedicated to studying passenger information systems, mainly developed in France. "Its aim was to improve user access to electronic inter-modal passenger information by developing guidelines for the presentation of information. Telematic-based information systems for public transport complement the conventional media (timetables, network maps, etc) by providing data which are likely to be more reliable in real-time. The general trends were: to make real time information available to the user; to extend information to multimodal solutions; to make information available by a great variety of means and to provide personalised data via interactive systems."

INFOPOLIS was one of the most complete reports on information systems for the time with rich descriptions about planning tasks, tracking tasks (orientation tasks and

decision making process) and assessment tasks (acquisition of experience and application in future journeys) . Its main conclusion revealed key points about the importance of the provision of information during all stages of the journey and some of these must be highlighted: “the multimodal passenger is forced to adapt their behaviour to the travel contexts at each step, because people tend to focus on only a few pieces of critical information at a time. In order to carry out these tasks the role of information must be to reduce uncertainty. The passenger needs the right information at the right time, and it can also be useful offering required information prior to a disruption at the point where another decision becomes possible. Moreover, as the passenger has no time to waste, the information must go to the user and the user must not go to the information, except for the pre-trip step where the use is less time-constrained. Therefore, it is very important to provide a coherent and efficient spatial-temporal system meeting the user's needs at all time-stages of the journey and at all relevant points on the journey. The project highlighted the importance of the information flow throughout the journey.”(INFOPOLIS 2 1999, p: 53-58)

The Fourth Framework Programme (FP4, 1994-1998) was to contribute to the optimization of transport systems in the Community. “The programme supported the development and the implementation of the common transport policy, in order to provide the basis for a trans-European multimodal network and specific research concerning the optimization of the individual networks. In general, researches contributed to the development, integration and management of a more efficient, safer and environmentally friendly transport system which was to ensure the sustainable mobility of goods and persons”. Among the projects related to public transport information, two were: INPHORMM Information and Publicity Helping the Objective of Reducing Motorised Mobility (1996-1999) and DIRECT - Data Integration Requirements of European Cities for Transport (1998-1999).

The Fifth Framework Programme (FP5, 1998-2002) was the European Union's main instrument for achieving its priorities for research and technological development (RTD). Key Thematic Programmes in FP5 which were fully or partly transport related comprised: GROWTH - Promoting competitive and sustainable growth; EESD - Energy, Environment and Sustainable Development; and IST - Creating a user-friendly Information Society. Among the project related to public transport information were: PROMPT (2000-2003, New Means to Promote Pedestrian Traffic in Cities) and

MOBILATE (2000-2005, Enhancing Mobility in Later Life: Personal Coping, environmental Resources, and Technical Support) and The UG395 - Attitudes of Disabled People to Public Transport (2001-2003), a project developed in UK.

The objective of the UG395 (DPTAC, 2001-2002) research was to assess attitudes of disabled people to public transport, the current use of public transport by disabled people, and the factors, which encourage or discourage disabled people from using public transport. “Its specific objectives were: To establish the importance of public transport to disabled people; establish the modes of transport currently used by disabled people; to determine the transport priorities of disabled people; to assess how disabled people currently rate public transport provision; to determine what disabled people consider are the priorities for improving public transport and to assess what deters disabled people from using public transport”. (*ibid* p: 2) The main general finding was that “disabled people feel that local and central government, planners and mainstream transport operators were not properly considering their needs. “Some disabled people would like the opportunity to work alongside these decision-makers and become more involved in future transport issues.” (*ibid* p: 8) Footway and road maintenance generated the most dissatisfaction, along with access for disabled people to transport vehicles and the frequency of public transport.

In the 6th EU Framework Programme for Research and Technological Development (FP6, 2002-2006), the Directorate-General Energy & Transport was involved in four thematic programmes dealing with energy and transport. The four thematic programmes were: Aeronautics and Space; Sustainable Energy Systems; Sustainable Surface Transport and Scientific Support to Policies. The priorities of Directorate-General Energy & Transport in the Sustainable Surface Transport Programme are: Galileo (European Satellite Navigation² System), air transport, urban transport (CIVITAS initiative), rail, inter-modal transport and logistics, maritime transport, road safety, intelligent transport systems, transport pricing and policy tools. The main projects in Public Transport and Passengers Information were: KITE - Knowledge Base for Inter-modal Passenger Travel in Europe (2007), LINK - The European Forum on Inter-modal Passenger Travel (2007-2009), SPUTNIC - Strategies for Public Transport in Cities

² European Space Agency own alternative to GPS: systems that provide autonomous geo-spatial positioning with global coverage.

(2006), PROCEED Principles of successful high quality public transport operation and Development (2006-2009) and eMOTION Europe-wide multi-modal on-trip traffic information (2006-2008).

In the current 7th EU Framework Programme for Research and Technological Development (FP7, 2007-2013), Directorate-General Energy & Transport is involved in three thematic programmes dealing with energy and transport: Aeronautics and air transport; Sustainable surface transport-rail, road and waterborne (development of clean and efficient engines and power trains, reducing the impact of transport on climate change, inter-modal regional and national transport, clean and safe vehicles, infrastructure construction and maintenance, integrative architectures) and Support to the European global satellite navigation system – Galileo and EGNOS (navigation and timing services, efficient use of satellite navigation). One particular project that looks at an alternative public transport system for older and disabled people is PICA V (2009-2012, Personal Intelligent City Accessible Vehicle System) which is developing a fleet of autonomous vehicles that old people can use when needed.

The recent projects supported under the FP7 programme (ICT Information and Communication Technology, (2007)) intend to “establish a link between fundamental sensing tasks and automated cognition processes that concern the understanding a short-term prediction of human behaviour as well as complex human interaction. The analysis of human behaviour, including localization and tracking of multiple people and recognition of their activities, currently constitutes a topic of intensive research in the signal processing and computer vision communities. This research is driven by different important applications, including unattended surveillance and intelligent space monitoring.” The projects are in development and results are not available yet.

2.1.1 Information systems development in UK (London) and in BR (Brasília)

Although the former studies listed above were carried out to develop technology and to understand user’s needs, in practical terms, the available provision of information to be used in public transport system (in London), e.g.: supportive services (via telephone) and the printed material (mainly, timetables), were deficient and difficult to obtain, to read or to understand until the end of 90’s.

In terms of UK policies, in The White Paper of 1998, “government committed itself to the establishment of a National Public Transport Information System (NPTIS) by 2000. The NPTIS required the integration of information across different public transport modes (bus, coach, tram, train, ferry and underground/metro) and regions of the UK. Set against this political background, public transport information systems advanced rapidly with a number of journey planning facilities available via telephone and over the Internet.” (Lyons, 2001, p: 228). See Kenyon *et al.* (2001), for Information Web Sites and Best Practice Guide. Transport Direct, an internet-based system that covers all modes of transport over the whole of Great Britain was officially launched in December 2004. In 2005 a reduced set of the Transport Direct Portal services was delivered through two new channels: PDA or mobile phone and through interactive television. The Transport Direct Portal was further enhanced in 2006 to accommodate accessibility demands.

With regard to tangible information system developments, it was only in 1993 with the consolidation of real-time technology that London Transport’s Countdown real-time information devices started to be installed on street and still today is demanded as an important device for the waiting stage of passenger’s information system because it helps take the uncertainty out of waiting for buses. Until 1998, London timetables for a route had the same content of information no matter where you were along the route. In fact, “Spider maps³” (colour code orthogonal route diagrams, see Chapter 4, Section 4.1), introduced in 2002, can be considered a very new kind of information provision in London.

Later, criticism in relation to the content of information in attempt to answer the needs of disabled people and their inclusion in the mainstream transport arrived at final end of the systems. The ‘Hackney Plus Bus’ scheme provided a network map and timetable customised for specific groups of disabled people that need to be register in advance as eligible users (more details can be found in Lynas, 1997). Some other examples are the Tube Access Guide, Tube map audio guide, Step-free Tube Guide, Large print maps and guides, Audio maps and guides, Guide to accessibility, Accessible Thames, Getting Around London and Walking for People with Disabilities (now available on TfL -

³ Spider maps: centred on a particular locality or bus station, they convey the route information in the schematic style of Harry Beck’s influential London Underground Tube Map (created in 1931) (http://en.wikipedia.org/wiki/London_Buse)

Transport for London - website). Better information systems were systematically created. Launched in 2002, Journey Planner for Londoners was an example of an interactive system where users can see the journey from origin to destination with details during the whole journey, although its use depends on the availability of computer technology literacy. An alternative interface for disabled people needs was incorporated in the new version of Journey Planner, by TfL in 2004/5. The 'iBus' project, currently implemented in 8,000 buses, covers the information necessary to support passengers (including disabled people) during the riding stage. More details are described on Chapter 4, Section 4.3.2, Information Systems in Real Life Conditions). Today, continuing efforts are dedicated to improve transport opportunities for disabled people (See TfL (2006-2009) Disability Equality Scheme).

Further, mobile communication technologies brought many studies which theorised about the requirements of passengers' needs and how users rate the usefulness of various types of information (Balcombe and Vance, 1998). The recommendations were that information should become customised, and in some systems, interactive and personalised. Current efforts are made to consolidate Mobile (Personal) Information Systems using PDA (Personal Digital Assistants, Huang and Li (2004), Li (2006)) and mobile phone (DAISY (Wainstein & Tyler, 2007), Personal Mobility Device) based on navigation system GPS (Global Positioning System) and photographic information. In London, the London Underground incident information can be notified of as soon as they happen, provided the users has registered for the free service via Journey Planner/TfL.

Emphasis on the integration of information and orientation systems to stimulate walking habits started around 2004 (TfL, 2004) and continuing evolve until today as health issues and to alleviate pressures on underground system, see AIG (2006) and TfL (2008b). Concepts such as spatial knowledge and the cognitive aspects of "wayfinding"⁴ to improve accessibility of Passenger Information Systems were gradually becoming important topics in transport research, specifically for the information system progress (TRCP Report 45 (1999) and TCRP Report 12 (1999), Huska-Chirroussel (2000), Borst *et al.* (2009)). Very recently, a comprehensive study

⁴ Wayfinding: "encompasses all of the ways in which people and animals orient themselves in physical space and navigate from place to place" Jahng (2008, p: 15). Extensive discussion about different definitions of the term is found in Chapter 3.

was developed in London, Legible London (CLP, 2006), which aimed to understand how people form their cognitive maps⁵. In 2007 a prototype multi-modal wayfinding system was commissioned in a limited area in the West End to trial methodologies. Central London areas of South Bank and Bank side, and Waterloo Station are now being piloted to further test and refine the scheme in different pedestrian environments (TfL, 2008a). An evaluation summary of the prototype qualitative and quantitative metrics used on the study is yet to be delivered by TfL.

In Brazil, a formal policy for Public Transport is not visible and most of the cities have suffered for more than 20 years as a consequence of this neglect. Moreover research development programmes have neither the same tradition nor the same economic support as in Europe. Most of the technologies implemented around the 1990s in the transport sector were adopted from Europe and United States and Canada. São Paulo, the biggest urban conurbation in Brazil, implemented a manual vehicle detection system in 1990 and in 1994 exchanged it for Automated Vehicle Identification (AVI). In 2005, São Paulo invested in the Advanced Vehicle Location (AVL) system with GPS on 4,000 buses. At the end of the 1990s Porto Alegre, another big city, implemented its AVI system which was similar to São Paulo. Automated ticket systems are already implemented in different capitals (and cities) of Brazil (São Paulo/SP, Vitória/ES, Porto Alegre/RS, Campo Largo/PR).

In terms of information to passengers, the main devices are based on internet services but are not fully integrated. Some examples are restricted to individual Bus Company web pages in which users can see route maps, itineraries and timetables. The level of interaction, however, is very low, as was the case in the early stages of information systems development in Europe. One of the most sophisticated examples is the system developed by “Transporte Coletivo de Florianópolis”, which provides the basic concept of Journey Planner/UK (origin-destination and bus service options to complete the journey directly or not, but without the user friendly environment and graphic resources). The metropolitan company in São Paulo (EMTU) presents a portal service where users provide origin and destination input and can receive some information about line number, route description, fares and information about the company.

⁵ Cognitive maps: The human ability to find the way on an environment. Extensive discussion about different definitions of the term, cognitive map, is found in Chapter 3.

There are some initiatives related to the development of devices for disabled people, mainly visually-impaired people. MIRU, for example, is a project developed at Federal Technological Education Centre (CEFET/Sergipe) which identifies each bus service number into a code recognised by a portable device for visually-impaired users.

In Brasília's particular case, in 2009, the current bus system is operating at a very low service level (comparing with European standards). Some reference about the accessibility levels of bus systems (particularly, bus stops) can be found in Carvalho (2003). Without strategic policies for public transport, its citizens agonize between an old vehicle fleet and alternative (and pirate) vans, inaccessible bus stops and a complete lack of information about services (information is available on a special telephone service, when the communication system works). Risk of assault and vehicle breakdown due to lack of maintenance are regular events reported in local newspapers. It is worth saying that regulations to offer a better transport system are in place at the Federal level since the promulgation of the law, in 1981 (Federal Constitution – Article 5° XV), the collection of district laws (n° 727/94, n° 1.432/97, n° 2.105/98) and the Brazilian Norms of Designs NBR 9050/94. From 2008, a complete alteration is expected on Brasília's Public Transport with the implementation of the Integrated Transport Plan (Brasília Integrada, formulated by the same planner of Curitiba's Accessible Bus System, and supported by World Bank (BID - "Banco Interamericano de Desarrollo"). More details can be found in Chapter 7.

2.1.2 Concluding Remarks

For more than 20 years an immense body of knowledge has been established in Europe to develop various topics related to transport. Specifically, projects involved with the evaluation of Passenger Information Systems can be divided into two main groups: development of technology to support advanced intelligent systems and research about user's needs and choices. The projects developed from the inspection of market potential to the consolidation of guidelines to enforce user interface; implementation of interactive systems in different stages; passing on to the inclusion of disabled people, development dynamic portable and personal type of information; to the stimulation of walking practice and environment navigation and improvements to inter-modal and multimodal interactions.

This period saw a huge development in terms of technological devices, and continuous improvements on user's interfaces (including considerations about user behaviour, cognitive process, mental load, explicit control and ergonomic design). However, in most of the projects, the focus was dedicated towards testing specific devices or treating specific stages of the journey. Practical studies about the flow of information during the journey (by public transport) to an unfamiliar environment are more difficult to find. Some studies explore navigation strategies in real situations; they were intended to study direct interaction with the environment. Some of them explore special features of restricted areas (Presson and Montello (1994), Raubal and Eanholer (1998), Cournell *et al.* (1999), Allen (2000), Sholl *et al.* (2000), Zacharias (2001), Ishikawa (2008)).

Others (Presson *et al.* (1989) and Roskos-Ewoldsen *et al.* (1998)) reproduced, in a simplified way, “the environmental setting and the means to interact with that environment. ...The majority of these studies involved a laboratory setting, where the environmental information was simulated and simplified, and it was conveyed to the subjects by means of maps, projected slides or scale models of the environment.” (Iachini and Logie (2003, p: 719) See also Boer (1991); Hintzman *et al.* (1981); Rieser (1989) and Rossano *et al.* (1995) and Sharlin (2009).

Another type of study relates close environment/small cities to virtual navigation techniques (at Campus: Hirtle (1998), Museum/Gallery: Conroy (2001) and virtual cities: Sadeghian (2006) and Omer (2007).

There are a few studies which explore spatial tasks in real open space environments (not constricted by building, shopping or university campus), such as: Heft (1979), Levine *et al.* (1984); Rossano *et al.* (1995); Warren *et al.* (1992) and Malinowski (2001), Montello (2004), Ishikawa (2006), Hegarty (2006). However, these studies mostly concentrated on performance evaluations of some specific part of the perceptual (mainly visual) system, such as mental transformation to localize position, angular distance, rotation, different perspective identification etc.

Iachini and Logie (2003, p: 719) suggested that “even when studies were carried out in more realistic settings, these were based on simplified procedures. The studies have not assessed the relationship between moving observers and real, complex environments and have not reproduced the feedback that is obtained from this interaction.” They also

suggested that the majority of research on environmental learning has been concerned with familiar settings, whereas less attention has been devoted to unfamiliar settings. “Moreover, the experimental situations were often static or participants were restricted in the range of movements they were permitted”. Iachini and Logie also stressed that “this lack of ecological validity could be a crucial factor which could undermine generalizations from experimental studies. A real-world setting might make a difference. For example, there is evidence that humans make fewer navigational errors in actual wayfinding than they do with simulated navigation (Cornell & Hay, 1984); in contrast, “more errors in estimated directions were found when subjects were tested within a large environment” (Byrne & Salter, 1983).”

Furthermore, Kitchen and Blades(2002) said that real environment situations offer an immense amount of clues that can help in orientation tasks. On the other hand Iachini and Logie (p: 719) warned that “many aspects of the real environment might make the interpretation of the data rather complex” and the level of externalities need to be taken into account on the design of the research.

In order to study how bus system information is used (e.g.: what type of information is provided, individual awareness of information, what type of information is selected by individual, how he/she adds this information to his/her previous knowledge, awareness of individual capability, how they use the information to complete the activity in real settings and interaction between individual capability and environment capability) it is necessary to look at the individual acting in real environment. Therefore it is necessary to establish a consistent method which allows individual analysis, while at the same time capturing the complexity (the interaction between individual and environment) of the study-task proposed.

The investigation of such cognitive and spatial tasks (construction of cognitive maps, wayfinding/navigation/orientation, discussed in more details in Chapter 3, Sections 3.1, 3.2 and 3.3) to achieve the final destination in practical terms, (theoretical defined as uninterrupted flow of information, described in the next section) should take into account individual differences and needs and, even more important, should understand the interaction between this individual and the environment, which might affect the flow of information.

Next section details the nature of the phenomenon to be study and the following section set ups the principles used to constructed the methodology approach.

2.2 NATURE OF THE PHENOMENON

This study investigates the use of bus system information in real conditions (planning and doing a journey by bus to complete an activity at an unfamiliar area). The focus is in the content and the flow (continuity) of information during the journey. In practical terms: how people use bus information (information pieces, e.g.: A to Z, route map) to go to a hospital at an unfamiliar area. The fact that the information selection and processing is highly individual and its use is highly dependent on the physical and social characteristics of the environment (accessibility level of the physical elements of the environment, e.g.: bus stop platforms, type of bus, crossfalls, accessibility levels of information system and orientation system) can illustrate the level of variables the methodology needs to tackle.

Ackerman (1995) introduced the notion of the continuous information chain, dividing the journey into stages and, for academic purposes, differentiated between information and orientation systems. Ackermann's information system is centred in the operational side of the system, whereas his orientation system is centred on information that can deliver cues of the environment in order to help the navigation or spatial orientation.

Table 2.1 illustrates the concept of information flow during the journey, which Ackerman called the "Information Chain".

Table 2.1 – Translated version of Original Ackermann Information Chain by COST 322

Stage of journey	Previous information at home	Way to/from the bus stop	Bus stop area	On/inside the vehicle	Transfer
Information System	<ul style="list-style-type: none"> • Timetable • Network Diagram • Telephone Service 		<ul style="list-style-type: none"> • Arrivals and departures board • Network diagram • Tariff information • Announcement • Service Centre 		<ul style="list-style-type: none"> • Arrivals and departures board • Network diagram • Tariff information
Orientation System		<ul style="list-style-type: none"> • Pre-orientation • Signposts • Guide strips 	<ul style="list-style-type: none"> • Signposts • Map of bus stop and environment • Guide strips 	<ul style="list-style-type: none"> • Announcement • Pictogram 	<ul style="list-style-type: none"> • Signposts • Map of bus stop and environment • Guide strips

A complementary classification of the Information Chain concept was described by Caiafa and Tyler (2002b) and is illustrated in Table 2.2. Using the same classification created by Ackermann, they collected, from literature review; the needs listed by disabled people, and then described the systems according to the tasks (or subtasks) that need to be done in order to complete each stage of the Journey Chain. This means that a set of information needs to be gathered to do the subtasks of each stage.

Table 2.2 - Information needs of the accessible journey chain (Caiafa and Tyler, 2002b, p: 240-241)

Objectives of Stages of the Journey	Pre-trip Information	The Walk	The Wait at The bus stop	The ride in the vehicle	Interchanges
Specific Information System	<ol style="list-style-type: none"> 1. Locate the origin 2. Identify the line service(s) 3. Locate the nearest bus stop 4. Locate the destination 5. Have a preliminary view of departure time, waiting time, duration of trip and costs. 6. Verify the need for interchange 7. Check accessibility of the vehicle 8. Verify the accessibility of the walk to the bus stop/terminal/station 	<ol style="list-style-type: none"> 1. Identify and check the correct bus stop platform 	<ol style="list-style-type: none"> 1. Be reassured of the bus lines that serve the stop. 2. Have an estimation of the time to wait for the service: 3. Be informed how the bus stop works – expression of the functionality of the bus stop environment 4. Tariff Information 5. Be able to review your plan or trace alternatives 6. Be informed about the bus(es) number as it approaches the platform 7. Have access to a Service Centre to enquire for more specific information 	<ol style="list-style-type: none"> 1. Identify the number of the bus line and destination 2. Know how the bus environment works 	<ol style="list-style-type: none"> 1. Have reassurance about the onward service 2. Have an estimation for the time to wait for the onward service 3. Be informed how the interchange point works – expression of the functionality of the interchange environment. 4. Have access to a Service Centre to enquire for more specific information
Orientation System		<ol style="list-style-type: none"> 1. Have access to information to reinforce the chosen path with important points : supermarket; hospital; churches, etc 2. Be alert to any kind of situation that might represent danger: crossing point, cycle lane; 3. Know locations of any resting facilities along the path 4. Confirm a unique identification for the bus stop in use. 	<ol style="list-style-type: none"> 1. Be informed about the distance between the adjacent bus stops (upstream and downstream) 2. Be informed about the kind of service facilities offered within a convenient radius of the bus stop (medical, educational, entertainment, food, market services) 3. Be informed about the condition and access level of the infrastructure within a convenient radius of the bus stop (footway condition, rest facilities, etc) 	<ol style="list-style-type: none"> 1. Follow the route along the journey by announcement of bus stops and route map 2. Have a general view about where the important destinations are along the route 3. Know where to get off the bus 4. Be informed about modal interchange points 	<ol style="list-style-type: none"> 1. Leave the arrival point and reach the departure point 2. Be informed about access to facilities: toilet, information points, lifts, help

Carmien *et al.* (2005, p: 240) also described the various activities involved in using public transport as “atomic cognitive steps”. In their view “each high-level activity (e.g.: plan, wait, and move) also involves a series of lower-level cognitive tasks. For example, while waiting users reflect on where they are in the journey, what vehicle they are waiting for, how to identify and select the correct vehicle, and where to move and board. In other words, every step - including the appearance of doing nothing — imposes significant cognitive loads.”

The ‘apparently’ simple task of doing a journey by bus actually involves a set of complicated mental processes which is individual and different (for each participant) and for each different environment (city cases: London and Brasilia). The following sections explain in more detail the concepts that comprise this phenomenon: the concepts of the Journey Chain and the Information Chain.

2.2.1 The Journey Chain and the Information Chain

The Journey Chain is defined by different authors (Frye, 1996; Tyler, 2002) to describe the sense of continuity of a journey. A journey starts before leaving home⁶ and ends when reaching the final destination. For the sake of explanation, a Journey Chain is composed of two phases: the Planning Phase and the Moving Phase. In the case of a bus journey, the Planning Phase consists of gathering some information to execute the journey by bus. The amount and the type of information used is the object of this research. The Moving Phase consists of six stages: walking to the bus stop, waiting at the bus stop, getting on (boarding) the bus, riding, getting off (alighting from) the bus and walking to the destination. Figure 2.1 illustrates the different phases and stages of a (single) Journey Chain.

The two particular stages ‘Getting On’ and ‘Getting Off’ were added as separate stages because they are considered complex and critical for disabled people. Complex because they imply a transition period in which the user changes from pedestrian to passenger and this ‘transformation’ involves many individual capabilities which could be critical because they can be dangerous e.g. the risk of falling, which for this particular age-group is very important. (DTI, Mackenzie *et al.* (2000) and Zijlstra (2007)).

⁶ Home is used as the place of reference where the journey is structured with the minimum amount of information desired.

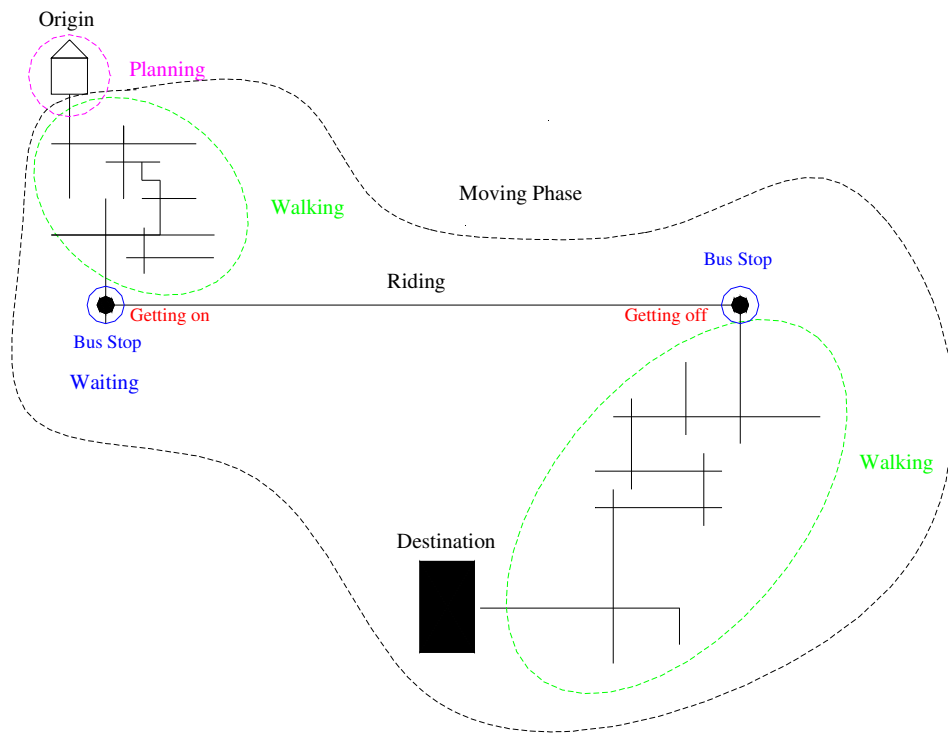


Figure 2.1 – Journey Chain: Phase and Stages

The concept of information during the Journey Chain was further investigated and combined with the concept of the Information Chain. Figure 2.2 illustrates the general function of information at different stages of the journey. In the *Planning Phase*, the individual will, in theory, prepare his/her journey. The actual details and amount of information gathered will depend on individual and environment capabilities. The *Moving Phase* is understood as the phase where the plan will be put in practice. It is actually the real journey, while the former (Planning Phase) can be understood as a virtual journey or a schema. Ideally, it is expected that an accessible environment will support the individual during the journey providing orientation during all the stages of the *Moving Phase* so the individual can confirm/update his/her plan. (See Chapter 3, Section 3.3.3, Figure 3.9 for theoretical explanation of this part of the phenomenon).

The Information Chain also needs to offer information to reduce stress during the *Waiting* stage and provides information to monitor the displacement during the *Riding* stage. More complex journeys involve changing to another route and even to another mode (Interchanges).

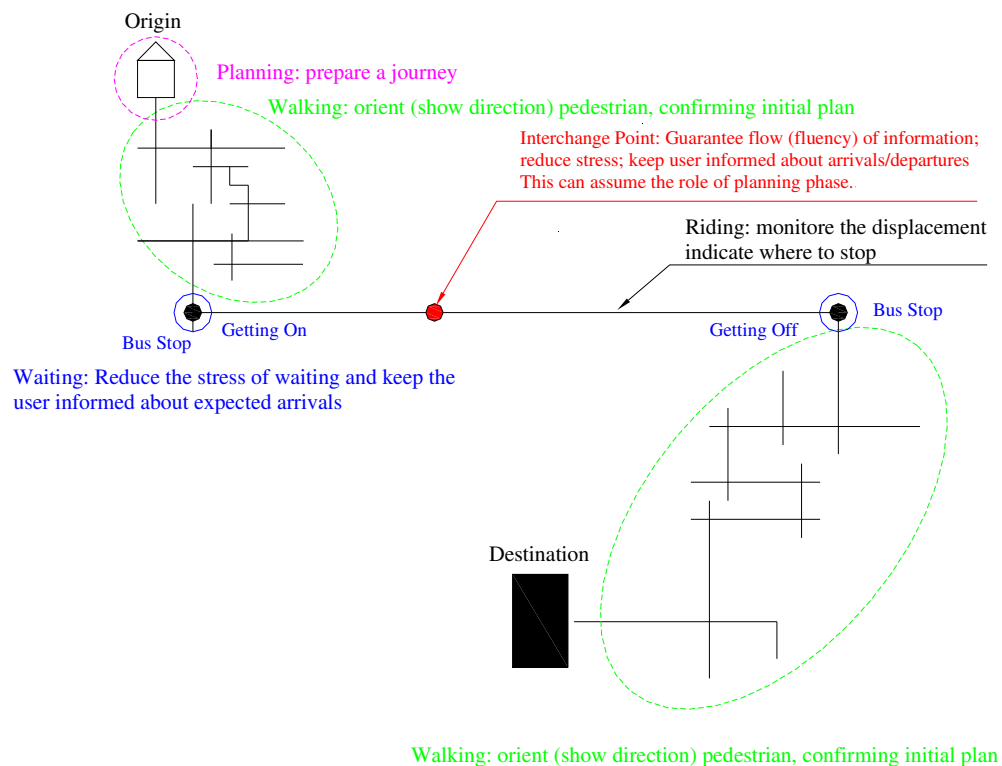


Figure 2.2 – Information function along the Journey Chain

The concepts of Journey Chain and Information Chain are based on the need to provide accessibility and improve mobility to guarantee users' independence. Frye (1996, apud Tyler 2002, p: 14) defined a journey, (public transport journey), as “a set of linked elements, each of which has to be accessible for the whole journey to be achievable”. She called this the “Accessible Journey Chain”.

Tyler (2002) stressed that each link of the chain must be in place for the journey to be accessible. The extra link in the chain consists of information and it can be more explicitly understood if it is defined as another chain, the Information Chain, which in fact, acts in parallel with the stages of the Journey Chain, as defined by Ackermann (1995).

Even though the accessibility⁷ and mobility⁸ topics are quite mature concepts⁹ in Transportation Research, Journey and Information Chain are rather recent concepts and

⁷ Accessibility: the ability to be approached, reached or entered and in this context represents the ease of reaching and using a bus (Tyler, 2002)

less explored in real conditions. It is necessary to establish what tasks and subtasks are necessary to complete the activity and investigate the importance of accessible information system for a target group.

Thus, due to the complexity involved in the study-task proposed, i.e.: understanding the information flow during the journey chain (or being more specific, understanding the information use to plan and execute a journey by bus into an unfamiliar environment), contextualised by the study-activity proposed to participants as: ‘visit a doctor in an unfamiliar environment’, determined by the choice to understand the phenomenon in a holistic manner, in order to capture the notion of continuity of the information flow (and the multi-disciplinary characteristics of the variables involved in the construct, listed on Table 2.2), it is considered important to study the individual in a real situation.

In summary, the nature of the phenomenon studied in this research is centred on the individual and in particular the individual’s behaviour in real settings. Users facing a problem-solving task (proposed journey to (un)familiar environment) are submitted to a set of stimuli (information provision – Information Chain) and make decisions (construct a plan using cognitive process) that are dependent on their own characteristics (Individual Provided Capabilities and knowledge/experience) and react to face the circumstances (Environment Capabilities Required) as they perceive them (cognitive process) in order to achieve their final destination (target) and be able to do their desired activity (motivation). The phenomenon is inherently individual and presupposes uninterrupted, (unless the interruption is a choice that participant made during the execution of the real journey, and therefore also an output (more details of this specific case is given within the result analysis in Chapter 7 and 8).

The next section describes some methodological consideration to study the phenomenon formerly summarised (last paragraph). After some discussion item 2.3.1 resumes how the study-problem is approached in this study.

⁸ Mobility: the ease of movement from place to place, and thus represents the ease with which a person can reach an activity. (Tyler, 2002)

⁹ The traditional concept of Mobility (meaning travel) has been put in discussion by the Quality of Life line of research demanding a more comprehensive definition (e.g.: psychological benefits of movement). See Metz (2000)

2.3 METHODOLOGICAL CONSIDERATIONS

This research seeks to represent the way each individual uses information provided by the bus system and how he/she finds his/her way in unfamiliar environment to reach the final destination and complete a hypothetical activity. Therefore, as stressed before, the analysis of the utilization of information is individual and throughout all the stages of a Journey Chain in real environment conditions. For this purpose a quantitative-only approach is unable to provide the necessary tools because they are not able to treat open-question types, (which are important in order to understand ‘the rationality’ of using particular information), they cannot capture subjective concepts (attitude, perception, feelings, needs, preferences) systematically and they do not explain how behaviour is influenced.

It is important, as defined by Lewis (1997), to consider the influence different factors can have on the specific individual. In this manner, a crucial step in this kind of analysis consists of a detailed description of the characteristics of each individual, using different techniques to account for their inherent heterogeneity of experience and skills. As highlighted by Schinazi (2006), this level of analysis cannot be conducted using only traditional statistical significance testing (such as Student’s t-test and ANOVA) which rely on group averages and the assumption of normal distribution because significance testing does not tell whether differences actually matter nor provide any explanation regarding effect.

Different qualitative approaches were considered in the field of transport studies. Some attempts at partially representing the broader concept of information use have ended up using different techniques to investigate passenger attitudes and perception: interview techniques (Atkins *et al.*, 1994), prototype models (TCRP, 1999), before and after behavioural surveys (STOPWATCH, Ouwersloot *et al.*, 1997), use of questionnaires (TRB (1995), DeJoy (1992) and Wixey *et al.* (2005)), Diary Methods (Wheeler & Reis (1991), Focus Groups (Seale, 2002) and Ranking (position on a scale in relation to others) Northampton County Survey, UK-1994 in TCRP (1999, Report 45).

Although some of these cases have used subjective techniques (interviews, ranking) recommendations are done with large samples, using aggregated analysis and submitting the data to statistical examination. The outputs vary from explaining users’

behaviour interpretations; travel decisions analysis to systems layout recommendations (many lists with detailed design characteristics are produced: information about size, colour, signs, type of letters, distance).

A different approach to study issues related with accessibility issues was presented by Carlsson (2002) who made use of the concept of functional limitations from the health and occupational therapy disciplines (CAOT, 1997 and WHO, 2001) to analyse accessibility assessment in public transport. A mixture of focus group interviews, live observation and critical incident technique were applied in moderate large samples (20, 133 and 150 participants, in different stages) in this study. Another study, conducted by Huska-Chirroussel (2000), has adopted concepts of cognitive psychology and spatial knowledge to investigate information process and different types of information (symbolic, textual, plan and pictorial information) with drivers and pedestrians. A mixture of questionnaires, psychometric tests and use of information types in real situations are the procedures adopted to extract data from participant, 32 drivers and 40 pedestrians, in this work.

The examples presented are not an exhaustive list but they offer an idea of different techniques and the scope of the methodology that has been developed to study public transport information use.

The emphasis in this study is to understand the use of information in the real environment and to allow inspection at the individual level. It consists of applied research with the individual behaviour being the focus of analysis.

Applied research refers to experimentation in the area of human behaviour change. Broadly speaking the tendency during the first half of the 20th century was to compare groups of individuals and the use of a statistical approach to psychology. In general, in Group Study Approach (GSA), participants were required to perform tasks within a controlled environment. According to a review by Paul (1967, 1969) the procedures used in applied research range from case studies with and without measurement to series of cases typically reporting percentage of success with no control group.

A review by Bergin and Strupp (1972) demonstrated that even under favourable conditions the applications of group comparison posed some difficulties:

- i. ethical objections (administration of treatment¹⁰ in one group while the other group becomes the no-treatment control);
- ii. practical problems (collection of larger numbers of clients homogeneous for a particular behaviour disorder is often a very difficult task);
- iii. averaging results (the obscuring of individual clinical outcome in group averages);
- iv. generality of findings (it is not possible to determine which particular patient characteristics are correlated with improvements)

Concerning the topics ii and iii listed by Bergin and Strupp, Schinazi (2006) added another observation, suggesting that the unsuitability of broadly classifying individuals into groups, could lead to deceptive results, because it does not allow for an important distinction between ability (“possessing the quality to perform”) and present competence (“actual performance”). For example:

“Consider a model-building task where an individual is asked to tactually construct a model by positioning different cardboard pieces in order to reproduce the spatial position and relation between different elements in an environment. An individual who fails to perform well in this task can sometimes be labeled as having poor cognitive mapping abilities. Here, it is important to consider that this sub-performance may be the result of present competence. This individual may have a perfectly accurate representation of the environment but the actual externalization of the representation is hampered by the task the individual is asked to complete. In this case, a model construction task where successful completion requires not only an accurate representation of the environment but also fine motor skills.” (Schinazi, 2006, p: 3)

It is useful to note that Schinazi’s terms provide a close match to those used in the Capabilities Model (Cepolina & Tyler, 2004 and Tyler (2006), which is discussed in more detail in Section 2.4 and Chapter 5): Schinazi’s ‘ability’ appears to be broadly equivalent to ‘provided capability’ and his ‘present competence’ is similarly equivalent to the relation between the provided capabilities and the capabilities required by the environment.

When taken together, all these characteristics mean that the person needs to be understood at the individual level because the choices and decisions being studied are highly individual in nature. In order to understand the individual, different types of tests need to be applied to backup the results within reasonable reliability.

¹⁰ Treatment: any set of measure or instruction

Also, there has been a gradual change in approach, from understanding only the individual to understanding the individual in the context of the environment, in order to identify how an individual experiences and interacts with environment¹¹. Therefore, in addition to understanding the individual, it is necessary to understand the interaction between the individual and the environment. In medical and psychological research words, for example: what type of clients under what conditions improve with a given treatment?

According to Eckert *et al.* (2000, p: 464) “the use of functional analysis provides an empirical conceptualization of problem behaviours and specifies individually-tailored treatment procedures” (Baer, Wolf, & Risley, 1968).” “A common approach to evaluating functional relations between behaviour and events surrounding its occurrence is to employ single case experimental designs” (SCD¹¹).

In 1970, Bergin and Strupp suggested that in order to achieve this, one must study one individual through a period of time, while changing the status (for example, adding and removing) of each dependent variable one at a time. They proposed using the experimental Single Case Approach (SCA¹²) for the purpose of isolating the mechanisms of change in the therapeutic process. The basic design of SCA is a time series for a single person and a single outcome, with a single time of intervention.

Horner (2005, p: 166) states that “typically SCD involves only one participant but may include multiple participants (e.g., 3 to 8) in a single study. Each participant serves as his or her own control. SCD are organised to provide fine-grained, time-series analysis of change in a dependent variable(s) across systematic introduction or manipulations of an independent variable. The effect estimate compares the outcome before and after treatment for changes in slope or intercept.” Horner (p: 166) also states that “SCD is experimental rather than correlative or descriptive, and its purpose is to document causal, or functional, relationships between independent and dependent variables.” “Such designs allow for the systematic manipulation of relevant variables to evaluate intervention effects for individual clients” (Christ, 2007, p: 451).

¹¹ Environment here is taken as a broader term that can vary from interaction in a classroom, in clinical settings (e.g.: inpatient hospital settings, outpatient treatment centres, or summer treatment programs).

¹² Other abbreviations used are SSD (Single Subject Design, Shadish (2007) and SCD (Single Case Design, Chirt, (2007))

The basic SCA format is known as ABA. A comprehensive description of the ABA process (and its variants) is given by Barlow and Hersen (1984). The initial period of observation (called the baseline or A-phase) involves the repeated measurement of the natural frequency of occurrence of the target behaviours under study. The primary purpose of the baseline measurement is to have a standard by which the subsequent efficacy of an experiment intervention can be evaluated. In the B phase the treatment is introduced. This is followed by a second A phase - a return to the baseline in which the treatment is removed and the initial state is reinstated. The differences between the two baselines are compared and the treatment is evaluated. Demonstration of a reliable effect is determined by replication of intervention and baseline levels of performance over the course of the experiment. "External validity of results from single subject research is enhanced through replication of the effects across different participants, different conditions, and/or different measures of the dependent variable." (Babson 2007, p: 76)

One of the criticisms of GSA applied to neuropsychology research ((Zurif (1989), Zurif (1991), Bates (1991), Caplan (1988) and Shallice (1988)) is about the impossibility to have pure replication on any kind of case study (single or group based). Zurif, 1989 (p: 243) commented that, "in most cases, group results will be less prone to idiosyncratic results than will a SCA, so that, over the long run, fewer discrepant empirical findings should emerge from analyses of group data." Another criticism related to the approach to "provide numerous trials on each task because patients may well develop strategies over the many trials which obscure underlying processes." The 'pro_GSA' alleged that they "can use fewer trials per subject and thus prevent the emergence of such obscuring strategies." (*ibid* p.243)

McKillip (1992, in Shadish 2007, p: 98) drew attention to the fact that SCA can have many variations, such as "the use of a control subject who does not receive the intervention, the removal and reintroduction of treatment, or the measurement of control behaviours." Shadish *et al.* (2002) added that, sometimes it is "modified by introducing treatment(s) at different time points for different subjects or focusing on different behaviours for different subjects Moreover, the number of observations of each subject varies considerably from study to study, often from just a handful to over one hundred. Finally, the design is sometimes extended to small groups of participants instead of just one, using the group mean rather than the individual observation as the unit of

observation over time.” Shadish (2007) complemented that, variations used in Single Subject Design practice also include multiple dependent variables and differing lengths of time. They introduce more complexity into account.

Most of the SCA experiments found in the literature are based on patients that have a physiological or psychological (emotional) problem, such as depression or schizophrenia. The treatments¹³ are also well-established in the following areas: use of drugs on schizophrenics and depression (Miller, 1973), punishments, isolation in educational environment (learning techniques Eckert, 2000), social change (Jayaratne & Levy, 1979), psychology treatment (eating behaviour (Agras, 1974), phobic patients (Leitenberg *et al.*, 1968), sexual behaviour (Barlow, 1969)) and alcoholism (Lawson, 1983).

Cardona *et al.* (2000, p: 44) conducted a SCA reversal study (ABA) to “examine the effectiveness of using a computer to increase attention on developmentally appropriate visual analysis activities of five children with disabilities. ... All participants were diagnosed with speech and other developmental delays. The child’s ability to attend to a task was measured by direct observation of three variables: visual attention to task, sitting tolerance and number of distractions.”

Others, like Eckert *et al.* (2000, p: 463) used SCA to “demonstrate the effectiveness of school-based interventions in the area of reading – a complex skill involving numerous components, including word decoding, semantic access, and sentence processing (Lombard, 1988).” “The analysis combined both skill-based and performance-based reading interventions on the oral reading fluency of four elementary-aged students identified with mild reading problems.” (*ibid* p: 465)

The type of research that used SCA is in the empirical research field. According to Christ (2007, p: 451) “the goal of empirical research is to initiate systematic manipulations that support conclusions regarding the cause–effect relationship between the independent variable (IV) and the dependent variable (DV).” In principle, the SCD “is limited to the use of dependent variable(s) that can be measured on many consecutive and closely spaced occasions and can be expected to change rapidly in

¹³ One must not considered that drugs, punishment, isolation are the only measures taken by therapists. Counselling, reinforcement and individual accompaniment are also part of the treatment on those case.

response to treatment introduction and removal.”, Shaddish (2007, p: 98). However, as can be observed by the last studies, the principles can be applied with more flexibility (e.g: using more than one variable (Cardona) or assessing complex skills (Eckert)).

Like any other design, SCDs have their own practical problems that sometimes impede their use. One important issue is the internal validity of the experiment: Campbell and Stanley (1963) propose that internal validity “is the basic minimum without which any experiment is uninterpretable” (p. 5). According to Christ (2007, p: 451) “Threats to internal validity are those factors that have the potential to provide alternative explanations for the observed effects.” Campbell and Stanley (1963) identified eight threats to internal validity: history, maturation, testing, instrumentation, statistical regression, mortality, and interactions between any of these various threats”, (Table 2.3). Christ (2007, p: 451) stated that “a study should be designed to assess for and, when possible rule out, the influences of extraneous events and conditions. When such threats and rival hypotheses cannot be assessed and ruled out, then the internal validity of the study suffers. “

Table 2.3 - Threats of Internal Validity

Threat	Description
History	Intervening events that influence measurement outcomes
Maturation	Change in participant behavior that is extraneous to their response to manipulations
Testing	Influence of testing, observation, or measurement on the dependent variable
Instrumentation	Changes or inconsistencies in how phenomena are assessed in a study (e.g., observer drift, change in observers, interobserver accuracy)
Statistical regression	Tendency for extreme values or observations to trend toward more typical levels over repeated assessments
Mortality	Loss of participants
Interactions	Result of combined influence of multiple threats

As exposed, both SCA and GSA have important limitations that should be considered when applied into research to study human behaviours and interactions with environment. The next section explains how the research problem is treated in this study.

2.3.1 The approach to the study-problem

First, considering the discussion about the nature of phenomenon, presented in Section 2.3, there is a clear need to understand the individual because the choices and decisions being studied are highly individual in nature. Second, the individual characteristics need to be captured, within reasonable reliability. To cover this, a Battery Test was devised in order to investigate the basic physical, sensory and cognitive functions of each individual and this is detailed in Chapter 5.

Third, there is a need to understand how the individual interacts with the environment, which, in this study, is to understand how individual uses his/her own rationality and thought processes to make decisions and choices in relation to public transport journey.

So, the problem referred to in the current study differs from the established ones in the medical area. The problem here is characterised as a complex skill: the strategies an individual uses to plan his/her journey by bus to do an activity. It is neither a typical psychological nor a social problem but it does have components from both areas. Decomposing the study-problem again: The individual is a user, facing a problem-solving task (undertaking a proposed journey to an unfamiliar environment) submitted to a set of stimuli (information provision – Information Chain) and making decisions (construct a plan using cognitive process) that are dependent on his/her own characteristics (individual capabilities provided and knowledge/experience) and reacting to face the circumstances (environment capabilities required) as he/she perceives them (cognitive process) in order to reach the final destination (target) and be able to do the activity desired (motivation).

The recognition of behaviour is not so trivial: here, the goal is to understand how individuals use the bus information system. In order to do this, it is necessary to understand what types of information are provided and how individual uses (selects/processes/uses) them to plan and undertake a journey.

The set of actions that allow basic understanding of information use are:

- i. Classification of information provided by transport systems in the two city-case environment, detailed in Chapter 4, and

- ii. Capture the use of information to plan and execute the journey in order to complete the activity. This needs to be done in three different moments of the journey:
 - 1st. selection of information pieces (inspection and choice of information piece)
 - 2nd. process of information: organization of information pieces in a plan format (and the part not formally represented on plan)
 - 3rd. use of this plan in real journey.

In order to achieve item ii, it is necessary to apply a technique that allows qualitative analysis of the individual, such as: careful analysis of problem and relevant details; implications in arriving at a solution and evaluations of own performance. The format adopted is the SCD_ABA format. An experiment was set up: INFOChain Experiment (Detailed in Chapters 5 and 6). The independent variables are the information (the current available and the set created for the experiment) and dependent variables are: the plan (selection and organization of information in the planning phase) and its internal process (process of information) and the journey (used information in the moving phase).

SCA was chosen because it is a technique that could systematically explore subjective constructs. The SCA in this study looks at the individual choice of information at general level: what types of information (e.g.: operational type (E_type), time-wise type (T_type) or accessibility-issues type (AI_type) – explained in Chapter 4, Section 4.3) were used during the baselines and treatment phases. In the INFOChain experiment, the baseline observes the natural way to plan and execute a journey (before being exposed to treatment). The treatment consists of the formalization of the Information Chain concept (the schema, Figures 2.1 and 2.2) and the introduction/exposition/awareness of AI-type of information created for each city-case. The effect that the treatment might cause in the subsequent use of information is then analysed in the return to the baseline condition, which verifies if any modification was observed. The SCA element of study was the plan (written and oral version). It is in the plan (the representation of the individual's strategy to complete the activity) that it is expected some sort of improvement. To study the details of the use of information (process and effective use in real environment), exploring the interaction between individual and the real environment, the Capability Model (CM) was combined with SCA.

The combined format SCA/CM allows the investigator to systematically evaluate important points in relation to the participant's individual capabilities (Provided Capability) and the capabilities demanded by the environment in which the activity takes place (Required Capability), in other words, allows thorough investigation of how easy the planning and execution of a journey in a real environment could be. More details of the Capability Model are presented in the next section.

Details of the methodology and considerations about the underpinnings of the choice (SCA/CM application) plus threats to internal validity of the experiment, listed by Campbell and Stanley, are described in Chapter 5 (Battery Test and Environment Inventory) and Chapter 6 (Single Case Analysis combined with The Capability Model) and Chapter 9 (threats to internal validity of the experiment).

The Principles of the Capability Model are summarised in the next section to explain the concepts underlying the interaction of the individuals with the environment in order to complete the activity proposed by this study. An introduction to the concept of individual awareness follows to explain what is going to be investigated at the individual level.

2.4 CAPABILITY MODEL

Sen (1993, 1999) presents the notion of functioning and capabilities as a way to think of “the various things that a person manages to do (or be) in leading a life” (functioning, (1993, p: 31) and capabilities represented “the alternative combinations of functionings from which a person might choose and which they might achieve”. According to Tyler (2006), in Sen's view “there is a distinct relationship between what a person could do and the activities they choose to do” and he argued that “the capability of a person concentrates on the concept of what their actual ability to achieve in fact entails” and continues ... “This suggests that a person has a set of abilities which at least in part determine which functionings are available to them to choose. This set is called their capabilities and these were related to the accessibility problem by Cepolina and Tyler (2004).” (Tyler, 2006, p: 338).

The Capability Model named by Cepolina & Tyler is a model which developed Sen's idea and analyses accessibility considering the interaction between a person, the environment and the activities an individual wants to pursue. The activity is defined as a set of tasks (choices). The environment consists of physical, social, legal and policy dimensions. The environment demands certain capabilities in any individual in order for them to be able to interact with it successfully; these are referred to as "environment capability requirements". The capabilities required by the environment thus define the conditions under which the activity can be achieved. The body structure and equivalent body function of an individual constitutes individual's capability, what is called "capability provision". Figure 2.3 illustrates the three basic components of the Capability Model.

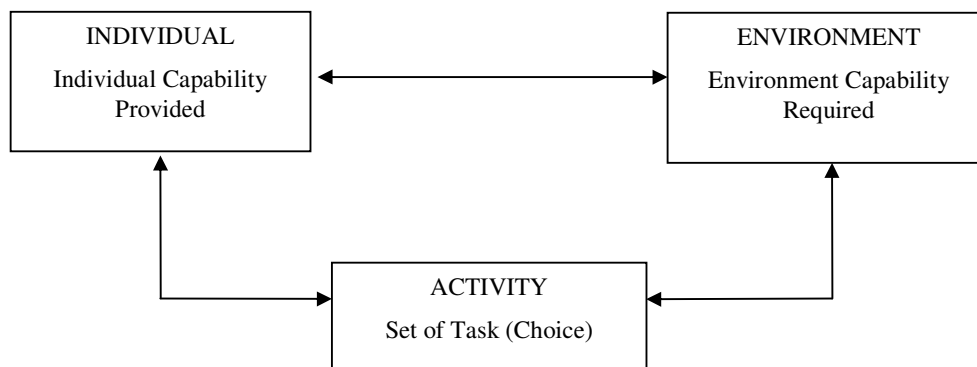


Figure 2.3 – The three basic components of Capability Model

As an individual engages in an activity, he/she needs to have ability to do the activity. This capacity depends on his/her body function and the environment. An individual might perform the activity with no problem, depending on the environment. How well this individual interacts with the environment will depend on how well the environment is adapted in the sense that a well-designed inclusive environment demands a lower level of capabilities than a badly designed or an aggressive natural environment. An activity is accessible to an individual if his/her capabilities are sufficient to meet the capability requirements of environment.

<p>Environment Capability Requirements < Individual Capability Provision</p>

An individual's capability can be altered (e.g. by providing equipment or a personal aid) but sometimes this procedure is not sufficient to guarantee access to an activity. If the activity requires more capability than it is possible to give to an individual (due to a

technological threshold, for example), the activity in that environment imposes constraints on the accessibility of that individual.

Another component that can be modified is the environment (e.g. natural physical and human-made physical world, other people, social systems, policies, rules and law). Several norms and rules are being updated in order to incorporate the principles of accessibility and mobility into engineering, architecture disciplines as well as guidelines for local authority communities to plan more accessible environments. (e.g.: London: DETR (1996), DPTAC (2002), Peck (2000), Department for Transport (2002), TfL (2005, Improving Walkability) and Legible London (2007)) (Brasília: NBR 9050/94, Código de Trânsito Brasileiro - CTB/1997).

Sometimes the environment is too hard to modify (topographically and/or economically not viable or culturally not acceptable) and in that case the activity will need to be modified.

The Capability Model examines how people interact with the activity-environment combination to see how capability requirements are matched by capability provision. In that sense, the philosophy of the Capability Model is used in this work: a journey into an (un)familiar environment will demand a set of information to be constructed by the individual. The individual needs to compose a plan to do the journey. The INFOChain experiment investigates the individual's capability to compose and execute this journey in the real environment and verify if the current information system provides the necessary information to do the activity. The principles used are described in 7 steps:

- i.* The individual has a set of capabilities (already adjusted as much as possible by medical professionals), for example: pair of glasses, hearing aids, mobility devices (crutches, zimmer-frame), among others.
The individual capability is assessed via the Battery Test (Detailed in Chapter 5)
- ii.* The problem is presented (one of the sub-tasks of the activity):
A Journey (origin and destination) to an (un)familiar environment is presented.
The Environment Capability demanded is captured by the Environment Inventory, also explained in Chapter 5. The level of information available in the two city cases, also part of environment capability, is illustrated in Chapter 4.
- iii.* The environment is roughly assessed.

The individual judges how much effort s(he) needs to deal with the problem based on his/her own knowledge of the problem: An initial load of effort is estimated; Some choices to deal with the problem are generated (do the activity, abort, postpone, ask for help). This is part of the individual cognitive processes captured by the application of SCA/CM in the experiment, described in Chapter 6.

- iv. The individual chooses an action aimed to overcome the problem.
The individual uses a strategy (selection of information and process a representation of a journey) to construct a plan for the journey. The individual uses strategies to put his plan into action (do the journey and use the information processed). This is the output of the SCA/CM methodology, applied in the INFOChain experiment, presented in Chapters 7 (London Case) and 8 (Brasilia Case).
- v. The chosen action involves specific body functions:
The strategy involves the ability to encode information and make use of it. Cognitive, sensory and physical functions are involved. The relation between the set of the subtasks to complete the activity and the set of individual functions is pre-defined in Chapter 5, Table 5.19.
- vi. The individual capability (physical, sensorial and mental) and the environment required capability (in this specific case: physical/social features of the journey and the level of information provision) are compared. The method of comparisons, the profile of the deviations, is also explained in Chapter 5, Section 5.8.
- vii. If the individual's provided capability (ability to compose a plan and physically execute the journey) exceeds the environment capabilities (physical features of environment, including the level of information provision) required, the individual can complete the activity (arrive at the destination, in time, as constraint by the INFOChain experiment set). The results of the INFOChain experiment (achievement of the activity proposed) are presented in Chapter 9, Section 9.5, Table 9.3.

Figure 2.4 illustrates how the seven steps of the application of the Capability Model, previously described, were applied to the INFOChain experiment. The INFOChain experiment verifies the information use based on the context of Accessibility

argumentation: Information (easy to find; easy to reach; easy to understand and easy to use) during all the stages of the journey (Journey Chain).

The activity is proposed: the mode (bus), the origin (always from UCL or UnB (Brasilia) and the destination (5 different ones) are given. Therefore the only degree of choice the individual has is to choose a bus service (restricted options) and the path to get to/from bus stop (variable but also restricted by time constraint imposed by a hypothetical schedule of the appointment presented to participant). The analysis of SCA/CM concentrates on outputs of the interaction between individual capabilities and environment capabilities (or more specifically individual capability awareness and information awareness, introduced in the next section) to achieve the activity ([S] Success/[F] Failure). Part of the environment capability required (the information set: E/T/AI type) is manipulated by the experiment.

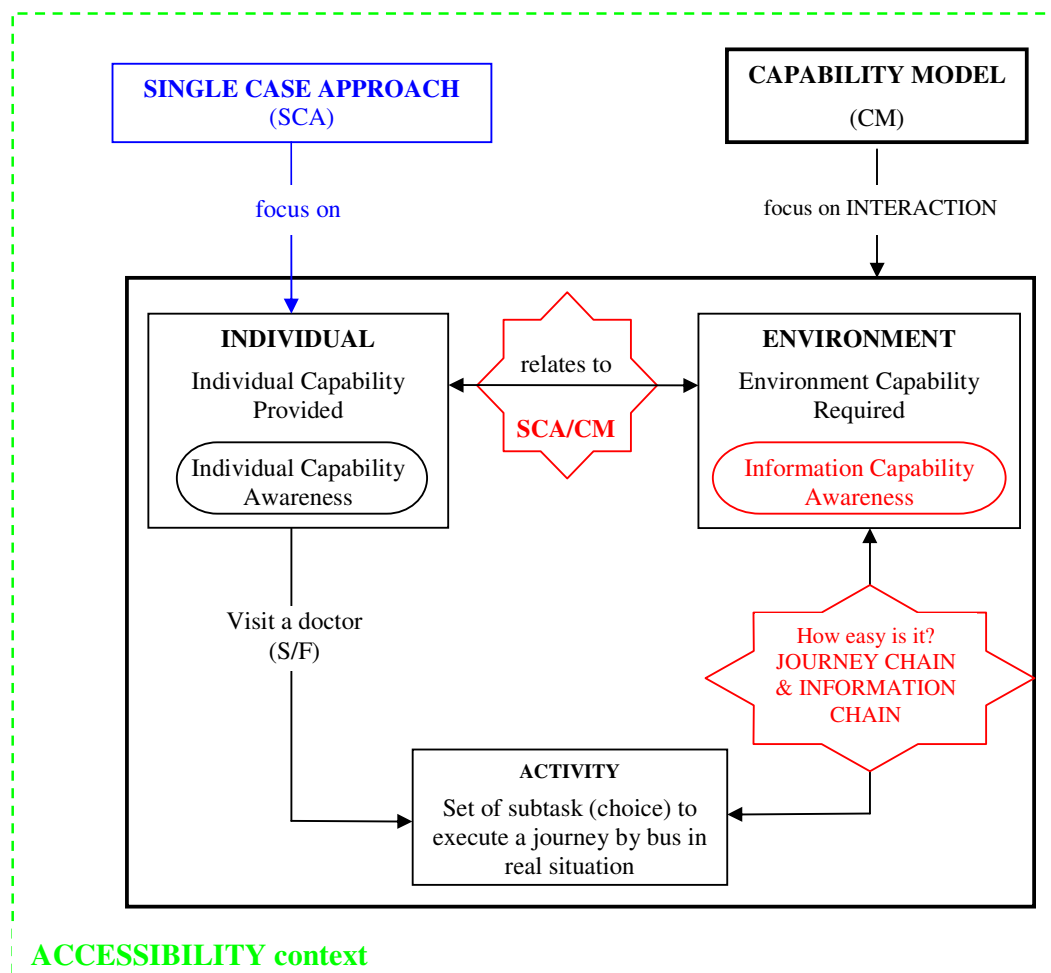


Figure 2.4 – Application of Capability Model in INFOChain Experiments

The rationality for the evaluation of Information Systems is: the more accessible the information system, the less capability is required and the easier the construction of the plan would be and the smoother the execution.

The definition of accessible information is complex although many of the regulations (norms of each country: UK and Brazil, detailed in Chapter 4) agree in essential features such as: information should be available in various formats and different media, easy to use, readable, legible, complete and fluent and free at the point of use. The quality and the content as well as the places where information must be available is variable and the access to it is very variable (from city to city) and dependent on different factors, such as: economic resources, technology domain, disability awareness and public transport policies.

The Information System is related to the ability to use it for one purpose (e.g. to do an activity). Two components can influence the actual execution of the activity. The first is the ability to construct the plan for the journey, which involves manipulation (selection and organization) of information extracted from the information system. The second is the capability to execute the plan of the journey and arrive at the destination (use the information), which involves interaction with the physical environment (including the orientation system found on streets).

Whatever the level of information system available (pre-condition: essential type of information to operate the system must exist), it is necessary to know that information exists and where to find it. Therefore, awareness comes as a pre-condition to use information and is therefore a key element in the study of Information Systems and Orientation Systems and this is discussed in the next section.

2.5 THE CONCEPT OF AWARENESS

For the purpose of this study, awareness is defined as the knowledge about something, even though this knowledge might not be conscious (formally represented on the plan).

According to Merikle *et al.* (2001, p: 118), “There has been considerable discussion in recent years regarding whether subjective or objective measures provide the more

accurate method for assessing if stimuli are perceived with or without awareness for summaries of these discussions see Merikle *et al.*, 2001 and Merikle & Reingold, 1998). Briefly, with subjective measures, awareness is assessed on the basis of the observers' self-reports of their conscious experiences, whereas with objective measures, awareness is assessed on the basis of the observers' forced-choice decisions regarding different stimulus states” or with intrusive devices placed on people to measure electrical signals.

Merikle (2001, p: 119) added that “the concept of perception without awareness has been shown to have a solid empirical basis, and an important direction for future research is to explore the ways in which stimulus information perceived without awareness influences conscious experience. The available evidence suggests that information perceived without awareness can influence conscious experience in at least two distinct ways. First, it can bias what stimuli are attended to, and second, it can influence how attended stimuli are consciously experienced.”

Still in the perception/awareness area, Kayashima (2003) defined awareness as “a metacognitive¹⁴ skill, in that it is a trigger to provoke the observation state in working memory¹⁵ and cognitive activities.”

In the context of Transport, awareness, according to Charles River Associates (2001), is a stage of information processing and application. It extends to the potential user’s state of knowledge and perception about a service and its characteristics. This state of knowledge is acquired via information perceived (consciously or unconsciously). Addler’s statement (Addler 1993) could be seen to complement this view, suggesting that the need for information changes as travellers become more informed about a network. Also, Jackson (1994) added that the usefulness of a system depends on different perceptions including time, costs, decision making effort and psychological effects. From another perspective, for an Information Systems to be considered effective (and not only technologically advanced), as Adler and Blue (1998) and Lyons and Harman (2002) state, there are a number of factors to regard as: awareness of information availability and the inclination and opportunity to access information

¹⁴ Metacognition: Refers to think about one's own process of thought (Sternberg, 1999).

¹⁵ Working memory: within cognitive psychology that refers to the structures and processes used for temporarily storing and manipulating information. (http://www.absoluteastronomy.com/topics/Cognitive_psychology)

alongside the provision of information items that are relevant to traveller's requirements.

“In multimodal information services, awareness of the details of travel alternatives for the journey the user want to undertake is essential in order to compare various mode options.” (Lyons and Harman, 2002, apud Grotenhuis 2007, p: 28).

In the present study, the awareness concept is investigated in practice. At first, awareness is divided into two single concepts: Awareness of Information (amount and type of information before journey - select and process - from the set of information items the individual has investigated) and Awareness of Capability (amount of information needed to deal with individual's condition to complete the activity in the environment proposed). Both concepts are explained, in detail, in Chapter 6.

2.6 THE TARGET GROUP: OLDER PEOPLE

In general terms, the methodology developed could be applied to any person but, in order to delimit the target population of this study and because the methodology needs to be tested more broadly (so at this stage no customised information needs to be produced, e.g.: tactile maps for visual impaired people or interpret for hearing people), participants will be restricted to people who: can use their visual abilities (with or without glasses/lens) to see information; can deal with the environment (they have lived in the city more than an year); can read and understand English or Portuguese (UK and BR cases respectively), are able to communicate orally and can use their main cognitive resources: perception, attention, thinking and memory. A Battery Test¹⁶ was prepared to identify the minimal requirements for the experiment among the target group.

The choice was to test the methodology with a group that do not have severe physical, sensory or cognitive impairment but are neither young nor fit – the older group was chosen, more precisely individuals over 65 years of age. “Although chronological age is an imperfect measure of what is meant by ‘old’, 65 is the traditional milepost of senior adulthood”, Coughlin (2001, p: 2). “Indeed, there is no consensus about what

¹⁶ Battery test: A series of brief different to test an individual's qualification for something.

constitutes 'old'. Any categorization by age obscures diversity of older people, physiologically, psychologically and sociologically.” (Bowling, 2005, p.2-3)

Coughlin (2001) states that a fundamental characteristic of development across the life-span, from birth to death, is that the human organism changes and that involves a variety of gains and losses.

In general terms the main declines found related to senses as people age are:

There is a gradual visual performance decline in the later decades of life, including reduced mobility of the pupil (“papillary miosis”), reduced flexibility in the lens (presbyopia), increased light absorption by the lens (senile cataract), reduced retinal illumination, degeneration of central retina (macular degeneration) and progressive loss of central vision.

Hearing deterioration (presbycusis) is also more dramatic later in life, accounting for 60 dB loss sensitivity by the age of 90, as pointed out by Mather (2009).

Odour identification declines after 60's. In their experiment Meisami *et al.* (1998) found that young subjects had over more than three times the number olfactory cells found in elderly subjects.

According to Birren & Botwinick (1951), Chaput & Proteau (1996), Miles (1931) and Welford (1977), age can also affect perceptual-motor function, eye-hand coordination. “Examples of age-related modifications of this function include delays in reaction time and movement time, decreased accuracy in reaching–aiming movement, decreased steadiness in the non preferred hand, decreased manual dexterity, and reduced speed in writing digits and words.” (Guan and Wade (2000, p: 151) Results from Guan and Wade (2000) suggested that the declines may be related to changes in strategic control and decrease in spatial alignment. Spirduso & MacRae (1990, apud Rodrigue 2005, p: 174) also suggested that advanced age is associated with decrements in speed and accuracy of motor control. But research conducted by Rodrigue *et al.* (2005) indicated that older adults can successfully acquire new skills and improve their performance with practice.

Greenwood and Parasuraman (2004, p: 16) found that aging also “alters the ability to deploy visuospatial attention, at first slowing the course of its development and increasing its dependence on external cues, but eventually impairing its ability to focus on a small region of space. These age-related changes may underlie the relative impairment of older people in performing search for conjunctions of features (Plude & Doussard-Roosevelt, 1989) or under conditions of what is termed “hard” search (Duncan & Humphreys, 1989) when there is high target–distractor similarity (Scialfa, Esau, & Joffe, 1998).”

In terms of cognition there is considerable empirical and theoretical work pertaining to the description and explanation of decline in cognitive abilities with aging, emphasising losses. On the other hand, some observers have focused on possible mechanisms for maintenance of cognitive competence and skills and on the dynamics between gain and losses (Baltes (1987), Baltes (1990), Perlmutter (1990), Salthouse (1987, 1990) Uttal & Perlmutter (1989)). Practical aspects related to cognition decline and mechanisms for its improvements are detailed in the next chapter, Section 3.4

So, the natural ageing process seems to affect vision; hearing; physical strength and flexibility; cognitive ability and, for many, susceptibility to illness and injury (Craik (1977), Craik and Salthouse (1992) and Poon (1985)). Some changes occur as the results of illness or disease, whereas others are a part of the gradual decline due to the ageing process (Ferrini, 1992).

These changes greatly affect an individual’s capacity to interact with and manipulate the physical environment. Salthouse (1990), Hertzog and Rypma (1991) and Kirasic (1991) found age-related decrements in the abilities to select good landmarks and to learn spatial relation along the route. Kirasic (2000) confirmed that older adults acquired less information about specific environment layout than do younger adults given the same learning opportunities. Rabbitt (1981), Salthouse (1982) and Cerella (1991), found that elderly people process information at a slower rate and this deficit relates to overall cognitive performance. More details about changes related to cognitive functions are given in Chapter 3, Section 3.4.

Problems encountered in different stages of the journey chain which are specifically related to ageing are reported in a document by DETR (2001) *Older People: Their transport needs and requirements*. Table 2.4 summarizes the main findings.

Table 2.4 – Problems with the Bus System according to older people

Stage	Problem descriptions
Planning	Lack of information; poor accessibility to services, network that does not meet the needs of older people, difficult making long distance trips, confusing community and voluntary alternatives
Walking	Heavy and fast traffic; poor road crossing facilities; pavement in poor condition (uneven surfaces) obstacles in pavement; no pavements at all; declining of local services; increasing risk of accident.
Waiting	Having to stand and wait for bus
Riding	Poor on-board environment; concern over delays and cancellations
General	Cost; infrequent; unreliable; the need to change bus; length of time to make trip; complicated connections; uncomfortable rides.
Concerns	Personal security (evening/night)

Two more significant documents expressing the importance of accessible bus systems and the main requirements of older people are: the Design for Older People - Help the Aged Transport Council's White Paper (1998) and the Disability Equality Scheme (TfL, 2006-2009) reinforcing the importance of involving disabled people in the development of the services provided. Tyler (1997) also presents some helpful tips to assist in the design of accessible bus systems taking into account concerns of older people.

Gilhooly *et al.* (2003) reviewed older people's opinions to explore the relationship between quality of life and access to public and private transport in UK. Among their key findings, two are particularly relevant to the present work:

- i. "Older people were found to be most reluctant to ask family members for lifts, even to hospital or GP appointments" (p:1)
- ii. "Train and bus operators were found to think of older and disabled people as a nuisance and as potentially reducing profits because of demands of free access." (p:1)

Wixey, Jones, Lucas and Aldridge (2005) highlight some important features among older people and the use of public transport:

- i. “They are more likely to walk and to use public transport”. They typically make fewer trips, not because of a reduced desire but because it becomes harder to access both the transport node (bus stop, rail station) and the vehicle itself, as the ageing process limits their functioning. Banister and Bowling (2004, p: 106) highlighted gender differences: “Elderly men make more walk journeys than average until they are nearly 80, whilst elderly women are close to the average until they are 75. Women make far more use of the bus, but here the elderly men are still above national averages. The elderly make less than average use of rail and underground and other modes.”
- ii. Fear of becoming a victim of crime affects the number of trips that they make in the evening, with most aiming to complete their journey during daytime or restrict their evening travel to locations that they are familiar with. These trends are more accentuated in those over 75 years of age.
- iii. Other barriers to travel include: absence of low floor buses, concessionary pass travel time restrictions; reluctance to travel during busy periods when they are less likely to be able to get a seat (after school hours); fear of travel when buses are full of school children; and feelings of resentment from other passengers if they take too long when boarding or alighting vehicles.
- iv. For older people, the planning of a new journey may require considerable effort (European Conference of Ministers of Transport, 2001). They feel that the computerised information systems available on most telephone numbers are hard to use and do not necessarily provide the advice that they require. They would prefer to speak in person to an operator, so they are certain the information they have been given is up-to-date and correct (Hine & Mitchell, 2001b).

Specifically related to information systems for public transport, two studies can be listed STOPWATCH (1992/1998). From applied research on Passenger Information System (See ROMANSE, DRIVE II), disaggregated analysis executed as part of the STOPWATCH Project (Southampton), for example, allows a brief view of an ‘elderly people’ profile: they generally are considered to be an intermediate level of bus user; with lower expectations of bus services; information about the system is acquired by experience or timetable booklet; they consider reliability and frequency important attributes of the system and they preferred printed timetables.

“In 2001, the Transportation Research Board (TRB) issued a report on “Communicating with Persons with Disabilities in a Multi-modal Transit Environment” [TRB 2001] to identify widespread problems that prevent people with cognitive disabilities from learning and using mass transit systems. The most common problems identified included: reading and understanding directions; accessing the correct vehicle; exiting at the correct station or stop; and understanding operator announcements.” Carmien (2005, p: 238).

2.7 CONCLUSIONS

This chapter has discussed the development of information systems having in mind the two different places where this study is applied, London/UK and Brasília/Brazil. Some approaches to study the problem were also presented.

In this work Information Systems are considered as complex sets of several sub-tasks. Understanding the flow of information and interaction the users make of it is therefore not an easy job. Analysis of users' behaviour has traditionally followed aggregated analysis with intense use of multivariate statistics (factor analysis, structural equation models and item response theory; before and after behavioural analysis and prototype examinations). Although they have shown acceptable levels of reliability the emphasis is on delivering the set of variables that might influence behaviour, but they do not explain how they can influence behaviour.

Because of the complexity of the theme, aggregated quantitative techniques have generated frameworks of limited practical applications. Alternatively, literature shows that SCA is a method of examination which can be used when the system being studied is too complex and does not always follow rationality external to the individual concerned. It is particularly useful to study the generation of new hypotheses, which later may be subjected to more rigorous experimental scrutiny. Dukes (1965) commented that the case study can shed some light on extremely rare phenomena or cast doubt on well-established theoretical assumptions.

In the present work, combined principles of SCA and The Capability Model (CM) are used as a technique to apply deep level analysis in order to identify different types of information used during the journey chain, in different moments (selection, process and use) by individual with different level of awareness. "The opportunity to learn is the primary importance - the refined understanding of the individual's use of information – and to gather information to interpret the different and even contradictory views of what is happening in relation to that individual". Supported by Stake (1995, p: 4):

"We do not study a case primarily to understand other cases.
Our first obligation is to understand this one case."

The sort of contribution this study is expected to make varies from suggestion to information design to training orientations for specific groups of people:

- i. Design analysis (content, form, media and flow), that is, evaluation of existing information systems and recommendations for new types of more inclusive information.
- ii. Training, meaning the possibility of analysing the singular learning mechanisms of users (in this case, older people) and the opportunity to offer more effective and personal training to improve bus use.
- iii. Exploratory studies, such as the understanding of users' information processes can be applied in further design of information systems for other groups of disabled people with specific needs

The next chapter reviews aspects of existing theories of mental process and spatial knowledge to understand acquisition and construction of strategies to navigate in the real environment in order to verify (a) if the existing techniques satisfactorily represent an individual's mental process for planning/doing a journey by bus and (b) whether any of these techniques might be suitable to support the proposed experiment (or whether a new techniques needs to be developed).

3 PRINCIPLES OF COGNITIVE PROCESSES AND SPATIAL KNOWLEDGE THEORIES

Chapter 2 generalised aspects involved in the use of the information system during the journey chain: selection, process and use of different types of information to complete a journey by bus. As a result of this analysis a Single Case Analysis approach combined with Capability Model principles was selected as the format on which the proposed experiment methodology will be assembled. This chapter presents an appraisal of the principles of cognitive processes and spatial knowledge theories that either affect or are a consequence of the way people structure information in order to orient themselves in real environment, meaning a real displacement in order to execute an activity.

The main objective of this exercise is to generate a characterization of the mental processes (cognitive process) involved in the creation of a plan and execution of a journey by bus. Due to the specifics of the subject and the lack of consensus among correlated areas that study the same topic (e.g.: psychology, geography, neuropsychology, man-machine interface), one possible conclusion from this review would be that there is no definitive existing model that can be applied to this problem, implying the need to assemble a general base in order to guide the execution of the task (journey by bus). Another possibility would be the adaptation of an existing model.

The first section discusses the different approaches to explain cognitive process whereas the second presents the schema adopted to support this study. Section 3.3 explores the different views about spatial orientations. Section 3.4 explains specific theories developed to study spatial knowledge apprehension: the construction of spatial knowledge and the representation of the environment. Section 3.5 highlights aspects that should be considered when dealing with older people. Section 3.6 summarises the discussion and justifies the approach to carry out the experiment.

3.1 COGNITIVE KNOWLEDGE

As introduced in Chapter 2, Section 2.2, the construction of a plan for a journey by bus involves different mental processes. Mental processes are studied in various disciplines

generalised in the term “Cognition”. Although this constitutes a huge theme for discussion there is no need to carry out this task in this study. An extensive discussion can be found in many classical sources to explain cognition, from the Gibsonian Schemata of Spatial Behaviour (Gibson, 1979) to the early theories of Information Processing ((Kirk (1963), Downs (1970), Pocock (1973), Lloyd (1976), Pacione (1978), Gold (1980), Passini (1992)) and the Transactional Schema Models by Neisser (1976) and Aitken and Bjorklund (1988). From the models designed to simulate navigation through the environment, the Computational Process Model (CPMs) of spatial behaviour ((Kuipers (1978), McCalla *et al.* (1982), Leiser (1987) and Gopal and Smith (1990)) to the connectionist’s model, based on Neural Networks (Lloyd (1997) and the Inter-Representational Network models (IRN) Portugali (1996). They constitute some examples of the evolution of the line of research in this field. In this study a simplified introduction is adopted, stressing the importance between different views.

Hayes (1991) defined cognition in a very simple way: what is going on around us? Figure 3.1 illustrates the process involved in the attempt to make sense of information and what use is made of it.

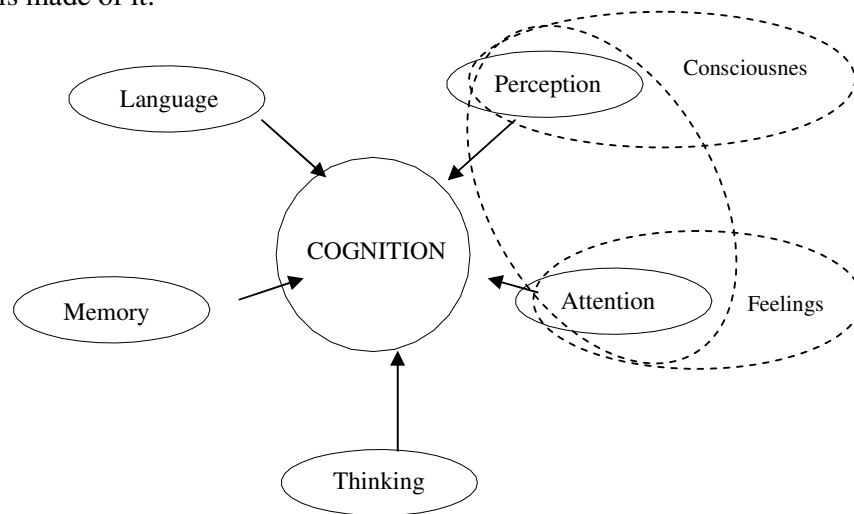


Figure 3.1 – The Cognitive Processes (adapted from Hayes, 1991, p: 2)

There are some discussions around concepts such as: perception, consciousness, attention and feeling as part of cognitive process, treated in more detail further in this section.

In another simple and schematic way, the main stages of the cognitive process are, according to Groome (1999), represented in Figure 3.2.

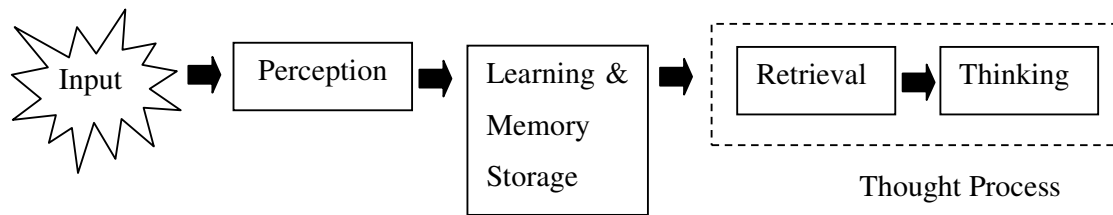


Figure 3.2 – The main stages of Cognitive Process

Groome believes that the brain is to some extent “modular” in that certain areas of the brain do perform specific functions. His view is supported by many others researches, especially those working on brain lesion studies. (Milner (1991), Warrington and Shallice (1984), Warrington and Taylor (1978), Porsner and Petterson (1990), Shallice and Evans (1978), Barcello *et al.* (1997), Schwartz and Georgopoulos (1987), Blakemore and Frith (2003), Perovic (2006)).

Another schematic view concentrating on perception illustrates what Goldstein (1999) defined as perceptual process, figure 3.3.

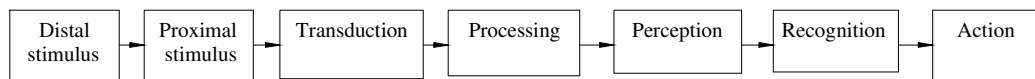


Figure 3.3 – The steps in the perceptual process, Goldstein (1999, p: 2)

According to Goldstein, the process begins with a distal stimulus in the environment (the actual object in the environment), specified in terms of physical characteristics. The proximal stimulus is generally defined as the pattern of energy impinging on the observer’s sensory receptors: a goal object is visible or audible, or detectable by smell and so can be approached from a distance. Then some of them stimulate the person’s visual receptors. Transformation of one form of energy into another form of energy occurs (transduction). The processing phase begins activating more perception processing. The electrical signals in neural signals (neural network, neural processing). The information is transformed in one’s perception (e.g.: recognition of friendly face or a target landmark). Recognition is described as “the ability to place an object in a category that gives it meaning” (Goldstein, 1999, p: 4). Perception and recognition are separate processes. Action follows perception and recognition. Perception is a

continuously changing process. Perception is a dynamic process studied by focusing on relationships between various steps in the perceptual process (stimulus-perception, stimulus-physiology, physiology-perception) using different approaches: behavioural, physiological (neurological), phenomenological, (psychophysical). Definition of the terms can be found in Annex 4 – Glossary.

It is worth mentioning that most of the studies conducted on cognition are concentrated on vision stimulus. Palmer (1999, p: 24) estimated that “the human cortex contains 10^{10} neurons and up to half of these may be involved in visual function.” The auditory system is much smaller and this might explain this tendency.

Another way to look at the general process of cognition is suggested by Neisser (1976 apud Kitchin and Blades 2002, p: 20). “An individual actively and selectively searches the environment to gain information that is relevant to his/her immediate needs. The individuals use an ‘anticipatory schema’ that structures which information is acquired from the environment. This schema would have been developed from past experiences – not necessarily in the same environment but rather it is made up of assumptions, beliefs, and predictions derived from environmental experience in general. He suggested that in most cases information processing would involve a combination of bottom-up (from percept to concept) and top down approaches (use prior knowledge about objects to interpret new visual input), as suggested by Figure 3.4, a simplified version of Neisser’s conceptual schema for cognitive mapping . In the process of searching for information and carrying out behaviour the individual will be constantly updating, altering, and adjusting the schema in the light of new information from the environment.”

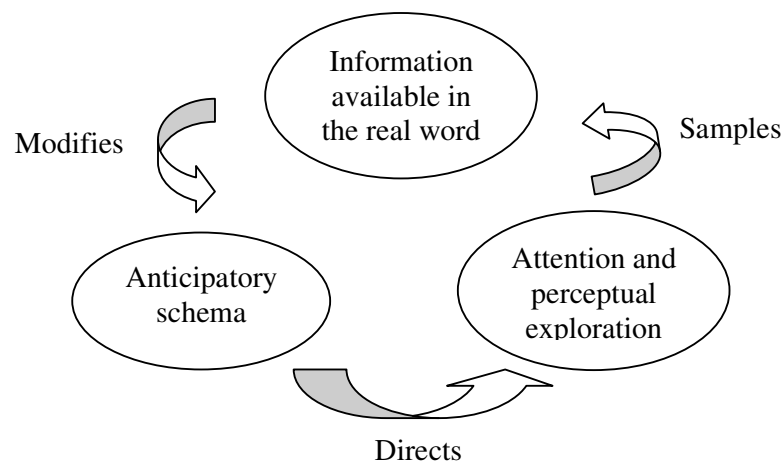


Figure 3.4 – The Perceptual Cycle, adapted from Cognition and Reality (Neisser, 1976, apud Hayes 1991, p: 11)

Lloyd (1976) model (Figure 3.5) emphasises the role of the individual in selecting the information that was processed. The starting point is the information. The information is filtered through a system of perceptual receptors. Meaning is given to the information by the individual value system and his/her stored image (cognitive map) of the real world. The filtered information is used to update the cognitive map and formulate a behaviour decision (mediated by preferences). This decision leads to reiterations of the whole process, creating another search for information from the real world until sufficient information has been acquired or to time/cost limitation acts to constraint the search.

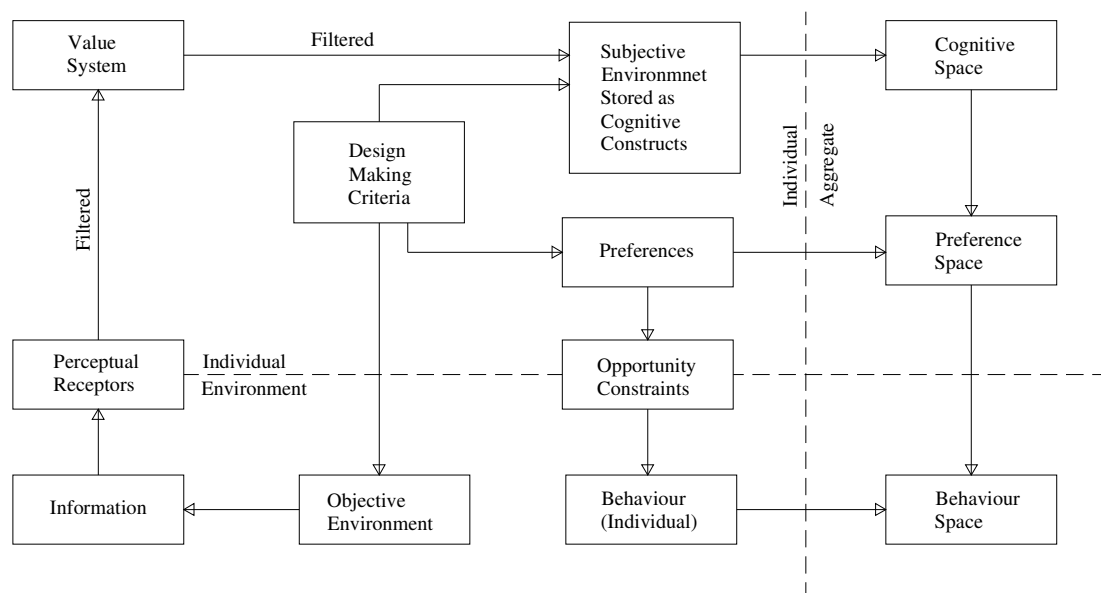


Figure 3.5 – The Lloyd's model of cognitive mapping (Lloyd's, 1976, apud Kitchin and Blades (2002, p: 17)

Kitchin and Blades (2002) explain that the role of the individual is recognised in Lloyd's model in different ways: it is the individual who filtered the environment information and it is decision by the individual that might result in the search for further external information.

Broadly speaking there are three main ways to explore human mind mechanisms. The first considers that "perception and cognition reflect independent or modular systems in the brain. Perceptual systems pick up information from the environment and pass it on to separate systems that support the various cognitive functions, such as language, memory, and thought." Barsalou (1999, p: 577)

The second also considers perceptual and cognitive functions as different issues but makes use of extensive language analogies for the codification of knowledge and construction of concept. They work with representational schemes that are inherently non-perceptual. “They inspired many new representational languages, most of which are still in widespread use today (e.g., feature lists, frames, schemata, semantic nets, procedural semantics, production systems, connectionism).” Barsalou (1999, p: 578)

The third sees perceptual systems as neuron manifestations with “the potential to represent a wide variety of concepts indeterminately. Cognition is inherently perceptual, sharing systems with perception at both the cognitive and the neural levels. It is assumed that the neural systems common to imagery and perception underlie conceptual knowledge as well.” Barsalou (1999, p: 577). This view begins by assuming that perceptual states arise in sensory-motor systems. “During perceptual experience, association areas in the brain capture bottom-up patterns of activation in sensory-motor areas. Later, in a top-down manner, association areas partially reactivate sensory-motor areas to implement perceptual symbols.” Barsalou (1999, p: 577) “Once a perceptual state arises, a subset of it is extracted via selective attention and stored permanently in long-term memory. On later retrievals, this perceptual memory can function symbolically, standing for referents in the world, and entering into symbol manipulation. As collections of perceptual symbols develop, they constitute the representations that underlie cognition.” Barsalou (1999, p: 577-578)

Depending on the focus of the research, an individual’s behaviour and models for information process can vary. The present work concentrates on the first two approaches described above (however, the findings obtained with the analysis of the experiment allow some inferences to be explored on the neuropsychological side as presented in Chapter 10).

The review shows that there are some general theoretical models that could be applied to the case of interest, but there is not enough agreement among researchers to support the necessary requirements to study the use of information to develop a spatial task in an unfamiliar real environment. The schema used to construct the INFOChain experiment is presented in the next section. The schema adapted the principles of the modularity approach to support the understanding of an individual’s mental processes while planning and executing a real journey.

3.2 THE INFOCHAIN SCHEMA

The INFOChain schema (Figure 3.6) was developed using the two main approaches of (1) the modularity theory: that perception and cognition are independent and (2) the schema theory: individual and language analogies (i.e.: schema) are used to codify knowledge, within the transport information context. There is an idea of a central functional system in which inputs are applied through different sense perception: visual, hearing/speech, cutaneous (haptic/ touch), chemical (taste/smell), movement (balance). In this central system, mental processes are performed through perceptual senses and memory modules leading to thinking process in order to do an action.

The functions of some of the listed senses are captured by the Battery Test, explained in Chapter 5. The individual process of information (how individual manipulates information within his/her previous knowledge) and make use of it (thinking/problem solving) is capture by SCA/CM application described in Chapter 6. The actual use of information is analysed in Chapters 7 and 8.

Derived from Hommel's theory of event code (Hommel *et al.* (2001), a perceived input automatically triggers an action, as if part of what is perceived is immediately oriented to match a response (perception to action) based on previous experience (schema). The user is in an interactive mode. He/She will use his/her senses to perform a task, which in this case is to move along until reaching the final destination. His/Her mind is devoted to construct the best possible solution to use the bus system.

Using the concept proposed by Information Chain (refer to Figure 2.2 and Table 2.2) , in the planning phase the individual has to search, retrieve and acquire information pieces from the available transport information system, provided he/she is aware of it. This encompasses tasks such as gathering, understanding, and completing information. The extent of the awareness of the existence of the information system is also important to this study. In the moving phase the selected/processed bus information needs to be put together with the environmental information adapting his/her perception of the (route/walking and route/bus) alternatives. This requires tasks such as tracking, comparing, re-evaluating planning and deciding. The whole activity demands effort and attention. A set of actions is taken to achieve the destination.

According to Shepard (1964), attention governs the perceptual features we extract. The definition of problems is strongly affected by what aspects of a problem people attend to. On top of that, according to Jones (2001), our attentional processes are very much affected by emotional arousal. Our feelings direct our attention, but they do more as well. The kinds of feeling we experience direct our behaviour into different paths. Jones thinks that because of attention limitations we are poor at making trade-offs. Attention and emotion compensate for what we clearly do not have: a comprehensively rational mechanism for sorting the relevant from the irrelevant and weighting the relevant aspects properly. According to Simon (1996), the “receiver must attend to and interpret incoming information. Oftentimes the problem for the receiver is not that he or she lacks information; often the issue is information overload. The scarce resource is not information; it is attention.” (apud Jones 1998, p: 10)

Therefore perception/awareness of information and its process and perception/awareness of the environment space (both subject to attention) are very important topics for the study-group of people (older people) especially because of the impacts, (related to working memory and the ability to inhibit irrelevant information), the ageing process can cause. More detail about the cognitive decline in later age is described in Section 3.4.

The INFOChain schema was created, first, to explain the nature of the object to be studied: the information flow during the journey chain. The nature of the input, the information piece (its presence - content, form and media - or its absence) will have an impact on the consequent activity (collection of tasks): visit a doctor (or, at another level, the journey itself). Second, to support the understanding of the cognitive process involved when the individual use (select/process/use) information to complete the activity (how individual use information during the journey in a real environment). Third, because with the schema, it is easier to describe and understand each module and each process separately and it is also possible to show the interface between them. This does not, however, mean that the processing of information is sequential.

As illustrated by the INFOChain Schema, the input processing (and consequently its encoding) and derived thoughts mediated by memory are extremely important. The set of actions taken (i.e.: to execute a journey by bus, provide it was planned) to complete the activity (i.e. visit a doctor in an unfamiliar area) is understood as an indicator of the quality of the plan and it is assumed that the final action, the journey, is continuously planned. The goals are constantly updated and might change based upon new information as it is derived from the data that are continuously acquired. Attention is required throughout the process because the (sub)activity itself (do a journey by bus) is classified as goal-direct, meaning an activity that consumes mental resource (input). Attention level is supposed to achieve peak levels during the “perception to action” and “thinking process” (generation of hypotheses, problem solving, decision making) stages. The sequence is repeated several times and adapted until the final destination target is achieved (or aborted, meaning another output for the initial problem).

The quality of the journey plan is another issue to be studied. The proposition here is that the quality of planning (how comprehensive it is) and the quality of the journey (how easy to execute it is) is correlated with the quality of input offered by the transport information systems (and processed by the individual); both, at the very beginning of the process and during the whole journey chain (according to the orientation system and accessibility level the environment has). This is how INFOChain experiment was set up to extract when applied to participants in London and in Brasilia. The results are presented in Chapters 7

(London) and 8 (Brasília), some comparisons and the actual achievement of the proposed activity are discussed in Chapter 9.

In theory, the better the input, the better will be the plan and the smoother and more accessible will be the journey (assuming that the execution of the journey will minimally follow the plan schema). It is expected that a more comprehensive plan (considering all the stages of the journey) will generate less errors, less anxiety, more confidence, and will free the working memory and enable attention to be focused if necessary, e.g. on an unexpected situation. So there is a clear need to understand which kinds of inputs are better for each user. This individuality is crucial to the process and the process is complex (as illustrated by Figure 3.6), thus reinforcing the importance of understanding the individual's (rather than the population's) needs and thus the basis for the use of SCA, as described in Chapter 2 (Section 2.3 and 2.4)

In the next sections the mental process involved in the determination of the practical side of executing a journey will be presented ("The Thinking", in the INFOChain Schema). They introduce theories about how an individual coordinates their knowledge in order to make a strategy to solve the problem of completing a journey. They present different views about spatial knowledge (spatial orientation or wayfinding and representation of the environment).

3.3 SPATIAL ORIENTATION

Spatial orientation or wayfinding are terms attributed to Lynch (1960) and are taken to mean journeying or travelling, particularly on foot. Many other basic definitions are listed in Conroy's thesis (2001). In her extensive analysis of the etymology of the word "wayfinding" she emphasizes that "a definition is required that implies not only the act of travelling from origin to destination but also the act of spatial problem solving and the person's cognition of their environment." (p: 24) She also emphasised that "an attempt to find or coin a single definition of wayfinding that is acceptable to a range of academic disciplines may be an impossible task." (p: 24)

Golledge (1995) states that wayfinding “appears to be one of the primary functions of vision in virtually all biological systems. The processes involved include cue or landmark recognition, turn angle estimation and reproduction, route link sequencing, network comprehension, frame of reference identification, route plotting strategies.” (apud Conroy 2001, p: 24). He listed some critical features of human navigation and wayfinding:

- i. The human navigation system interacts with and adapts to the environment in which it is navigating;
- ii. Navigation proceeds by initiating body motion and receiving and translating sensory feedback received from self-perception of motion over time;
- iii. The imagery developed by sensing the environment constrains the nature type, speed and direction of motion.

Gibson (1979) stresses “the importance of perception and specifically visual perception to the act of wayfinding, however she also concedes that there is more to wayfinding than purely responding to visual information in the environment.” (apud Conroy, 2001 p: 24)

In consonance with Gibson’s work, Downs and Stea (1973) define wayfinding as comprising four stages. “The first stage is that of orientation or the determination of both self-location and target-location (or estimated target-location) within the environment. The second stage is initial route choice, the selection of a route from starting location to target location. Stage three is route monitoring, constant checking of the route taken, modified by estimates of self-location and target-location (stage one) and reassessment or confirmation of route choice (stage two). The final stage of the process is the ability to recognise when the target has actually been reached.” (apud Conroy 2001, p: 26)

For Blades (1991), the term wayfinding describes “the ability to learn, recall and follow a route through the environment”, (apud Fenner 2000, p: 165). Wayfinding is a goal-directed activity in which people have to utilise some form of strategy in order to reach a particular destination, (Fenner 2000, p: 165). One important factor in the development of wayfinding skills¹⁷ may be changes in the ability to form and utilize cognitive maps.

¹⁷ Wayfinding skills: (any strategy that can make spatial task easier, e.g.: use part-whole; straighten edges, put things closer to landmarks, priming semantic relations.

Cognitive Map is another term that has many definitions. The human ability to find the way in an environment is possible because a person is able to organise information into some form of structure (or framework) that best suits his/her capacity/limitation. The specialised structures that humans use are called “cognitive maps”. Lynch uses it as “the extent of individual’s knowledge of an environment.”

“Being able to find one’s way in an environment involves a complex set of cognitive processes”, as illustrated in the previous section (cognitive mapping). (Prestopnik and Roskos-Ewoldsen, 2000, p: 187). Decisions in cognitive terms will be transformed in behavioural terms to actions. Prestopnik and Roskos-Ewoldsen (p: 187) illustrated that with a descriptive example: To move towards a specific destination, one must know and “remember the names of streets, where the streets are located and how they lie in relation to each other.” Landmarks follow the same approach (except the name is not always required). “On top of these interconnected memories one must know where he/she is in relation to the streets and landmarks, and must update this information as he/she travels through the environment” (p:187). Working memory is heavily used during orientation. But memory capacity and the degree of attention employed will vary according to individuals.

Besides their own characteristics, features of the environment might exert an impact on individuals. Weisman (1981) demonstrated four categories of environment variables that influence wayfinding:

- i. Visual access of familiar elements (reference points)
- ii. Degree of architectural differentiation between zones
- iii. Symbols and directional information utilization
- iv. Plan configuration (simplicity and regularity facilitate comprehension)

So far, one can conclude that the orientation task involves both environment characteristics and the individual’s previous knowledge and future choices of actions guided by some kind of information. According to one’s own level of knowledge of the area, one will adopt a strategy to move, develop a global plan to orient the movement, follow and adapt it subject to environmental variables.

Taking into account the schema presented in Figure 3.6, a situation is illustrated in Figure 3.7 describing lots of sub-actions that compose the final action to achieve the target destination. It is supposed that an individual engaging in a bus journey to/in an unfamiliar environment would trace a plan, represented in the figure by the cloud-symbol – participant's mind. The quality of the plan is subjective and unique to the individual's condition and his/her awareness of environment, including the awareness of information available to compose the plan. During the journey he/she will perceive environmental cues (recognition) and attempt to match them to his/her plan, represented in the figure by the dotted lines (e.g.: the search for visual landmarks or audible announcements). The whole information (planned and gathered from the environment) will lead the individual to specific actions (e.g. push the stopping button, stand up, get off the bus) to achieve the destination on time. References that could be used in a future journey will be updating enriching his/her original plan.

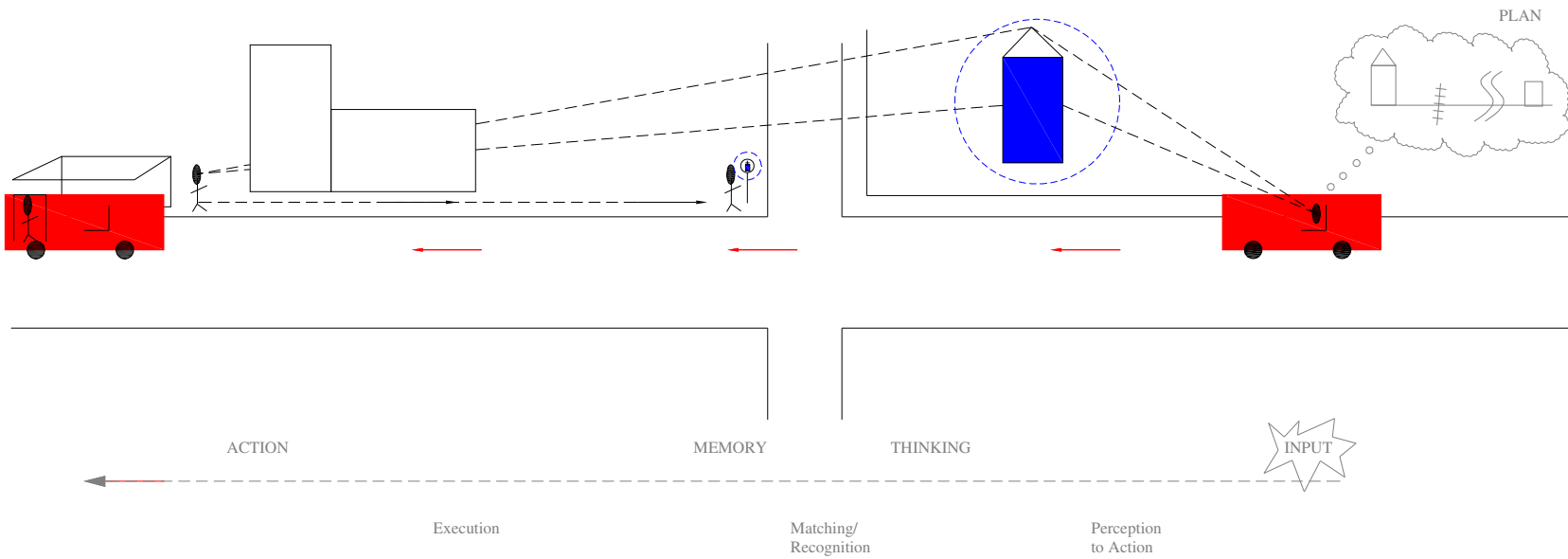


Figure 3.7 – The INFOChain Schema for Cognitive Process (Figure 3.5) applied to an ordinary situation of doing a journey by bus.

The ordinary situation of the execution of a journey by bus to an (un)familiar area is a spatial orientation task, a kind of problem-solving task and demands individual's own choice of strategies. The relevance and the understanding of these strategies are the core of the experimental exercise conducted in this study. Spatial Cognition is the general term used to refer to acquisition and use of knowledge about large-scale space (Thorndyke and Hayes Roth, 1982). The comparison of theories about the actual construction of Spatial Knowledge and the Representation of Environment is another topic where it is difficult to find unified agreement between specialists as will be discussed on the next section. The difficulties arise because, according to Thorndyke and Hayes_Roth (p: 561), "people have various type of spatial knowledge acquired from different sources (e.g. map, verbal instructions, photographs) and they use different procedures to make spatial judgements". Tversky (2000) added that the same spatial knowledge can be considered in several different frames of reference and can be used for different purpose.

3.4 ASPECTS IN THE CONSTRUCTION OF SPATIAL KNOWLEDGE – REPRESENTATION OF THE ENVIRONMENT

3.4.1. Levels of Knowledge

According to Kitchin and Blades (2002) individuals will differ in their knowledge of the same environments because few people will have a comprehensive knowledge of location, distribution, density, dispersion, pattern, connectivity and hierarchy. This is feasible because comprehensive spatial knowledge is not usually necessary when making spatial choices as much decision-making and behaviour in the environment can be based on three levels of knowledge: declarative, procedural and configurational.

- i. declarative knowledge consists of isolated shots of objects, functions as a landmark reference with meaning and significance attached. Examples: landmark, routes and areas. Liben (1981) described it as a database of specific spatial features.
- ii. procedural knowledge is the knowledge exercised in the performance of some task. It consists of rules used to synthesise declarative knowledge, and is required for wayfinding behaviour and route learning (route).
- iii. configurational knowledge is the highest level of knowledge, involves information about spatial relations (survey).

Declarative knowledge is a factual knowledge, it is knowing 'that' (e.g., that Oxford Street is a very important commercial street in London), as opposed to procedural knowledge, which is knowing 'how' (e.g., how to get from St Pancras Church to Oxford Street).

Declarative knowledge can be further divided into, according to Tulving (1972) and Anderson (1983) (in http://nwlink.com/~donclark/learning/declarative_knowledge.html)

- i. Episodic knowledge: memory for "episodes" (eg., the context of where, when, who with etc); usually measured by accuracy measures, and has autobiographical reference.
- ii. Semantic knowledge: Memory for knowledge of the world, facts, meaning of words, etc. (eg., knowing that the first month of the year is April (alphabetically) but January (chronologically)).

Procedural knowledge involves identification of locations on a path where a decision to continue using the planned or usual route is made. In other words, Deakin (1997) defined procedural knowledge as "the stored sequence or decisions about how to get from one place to another. It is the knowledge of sequential locations without the knowledge of general relationships." Thorndyke (1983) suggested that there are two types of procedural knowledge. The first is unordered productions - behaviour along a route is dependent on a series of independent pieces of spatial knowledge. Rather than information being combined into an understanding of the whole route, a person relies on taking particular actions at particular decision points along the route. The second type of procedural knowledge is ordered productions - order information is known and this allows whole routes to be remembered without having to traverse them.

"Configurational knowledge is characterised by the ability to generalise beyond learned routes and locate features within a general frame of reference. It is considered to be more holistic than procedural knowledge and incorporates Euclidean, rather than solely topological relationships." It forms a comprehensive spatial knowledge system that provides detailed information about the associations between places and their relative positions and permits the connection of independent routes; this is the basis for making spatial inferences and propositions (Allen 1985; Golledge, 1992 apud Kitchin and Blades 2002, p: 59).

Kitchin (1995) believed that configurational knowledge is merely an advanced form of declarative knowledge and that it is the procedural knowledge – consisting of rules and heuristics used to access and manipulate the declarative knowledge for a specific spatial task – that generates the overall understanding of a whole route or journey.

Other terms used to explain similar concepts of the knowledge individuals can develop about an area are referenced as route knowledge and survey knowledge, taken as an individual's strategies:

- i. Route knowledge is the knowledge about the movement necessary to get from one point to another.
- ii. Survey knowledge refers to an integrated understanding of the layout of a space and the interrelationships of the elements contained therein. (Thorndyke and Goldin, 1983)

Route strategies, according to Lawton (1994, apud Prestopnik and Roskos-Ewoldsen 2000, p: 179), “use a sequence of instructions allowing one to navigate from one place to another. They centre on a direct route from one place to another, often using landmarks, and have a local focus. A route strategy is typified by directions to turn right or left at particular landmark. This type of strategy is relatively inflexible, as the person who uses them is forced to rely on a specific way of moving from place to place. Individuals who depend on route knowledge become easily lost if they deviate from the learned route”. For Chown *et al.* (1995, p: 11) “landmarks function as a kind of environmental index. Recognising nearby landmarks is enough to tell one where one is in a familiar environment. Consequently, the fundamental property of landmarks is that they must be uniquely identifiable.”

“On the other hand, survey strategies use an overall cognitive map of the environment to integrate information about places and the relations between places. Survey strategies have a global focus and rely on more universal concepts that do not change when the direction of orientation changes (cardinal directions or the sun navigation). The survey strategy is a much more flexible strategy than the route strategy, and individuals using this strategy can easily find shortcuts that deviate from the originally learned routes”. (O’Keefe and Nadel, 1978, Lawton, 1994, apud Prestopnik and Roskos-Ewoldsen 2000, p: 179).

Devlin (1976) found that routes are very important in the early stages of knowledge, when an individual first learns about an environment, with the landmarks becoming more important later. Siegel and White (1975 apud Fenner *et al.* 2000, p: 166) suggested that “routes are important units within an overall cognitive map and that development of the general structure or schema for a route starts with knowledge of landmarks, with little about the spatial relations between them.” The spatial relations between places are acquired in a series of stages, like a sequential order of landmarks along the route. Then, with more experience, comes the spatial relationship between landmarks and eventually a concept of spatial layout of the complete route. Finally, there occurs an integration of the knowledge of different routes into a holistic sketch map of the area. Thus information from different route schemata is combined into map-like integrated representation of the spatial layout of landmarks and routes of the area.

In contrast to Siegel and White’s theory, Yeap and Jefferies (2000, p: 89) suggested that “the process should begin by computing a description of each local environment visited by identifying the boundary. This primary description role is as a container for describing what is available or happening in the current local environment. Thus each description of local environment does not need to be measured with much precision.” ... “What should be remembered first is a fuzzy description of each local environment and a collection of these descriptions may or may not form a connected whole.” (*ibid* p: 111)

Directly related to levels of knowledge are frame of references, defined by Tversky (1981) and Moar and Bower (1983) as heuristics used to relate places to one another. They help people to orient themselves and provide ‘sense of direction’ (Kuipers, 1978). They are discussed in the next section.

3.4.2 How do we use representations of space?

A spatial framework reflects the way people normally conceive their perceptual world, based on their interactions with it.

In physical space, elements such as buildings and landmarks may exist as a unique occurrence and location and they remain fixed, but in cognitive maps they may become altered. Everyday tasks often require the knowledge of the spatial location of one object in relation to another. Spatial terms specify the location of one object (located object) by

referring to the known location of a second object (reference object). To find the located object, one would start at the reference object, “move” (physically or mentally) in the direction specified by the spatial relation and search the surrounding space for the located object. A three dimensional spatial framework is created to store, retrieve and verify locations relative to their own bodies – egocentrically, or allocentrically, or topologically or even multidimensionally, rather than within strict coordinate systems. See figure 3.6, terms are explained throughout this section.

For Chown *et al.* (1995), a frame of reference appears when one has already identified important landmarks, traced the route and is now in a process called direction selection. In effect, they are composing the survey map. In the transition from route maps to survey maps, first, an objective frame of reference is developed. “One is no longer recreating specific experience but is now integrating experiences to form a coherent whole. Secondly, the determination of spatial relationships of objects that are not closed is required. The two types of route thus developed provide the system with useful complementarity and redundancy helping to make it robust” (Chown *et al.* 1995, p: 9).

A reference frame may include an origin, a coordinate system, a point of view, terms of reference and a reference object. According to Huska-Chiroussel (2000), theorists on spatial language have distinguished three different frame concepts (i, ii and iii).

Different names were used to refer to them:

- i. Deictic or viewer-centred or egocentric
- ii. Intrinsic or object-centred or fixed frame or allocentric
- iii. Extrinsic or environment-centred or global frame or topological

In an Egocentric framework, the relations are conceptualised in respect to the sides of a central figure. For example: routes are organised on the basis of the body referent or locating an object with respect to one’s body. They are characterised by serial aspects rather than spatial ones. They have no plasticity. Their reliance is upon direct experience (Chown, 1995). “Egocentric frames of reference (observer-based metrics) define spatial positions using the body, or a specific part of the body, for instance, the trunk or the head, as a constant point of reference.” (Burgess, Spiers, & Paleologou, 2004 apud Ball 2009, p: 1585).

In an Intrinsic framework, relations are conceptualised in respect to chosen objects. The attention is focused on the object. This approach is thus more functional. “Allocentric frames of reference (object-based metrics) consider spatial relations between objects, and rely on the external environment to define space, that is, by using landmarks” (Burgess, Spiers, & Paleologou, 2004 apud Ball 2009, p: 1585).

In an Extrinsic framework, relations are conceptualised in relation to the environment. They extend beyond fixed frames. Gärling (1986b) believed that these frames of reference are the ones that individuals can use to orientate themselves in unknown environments.

Figure 3.8 illustrates them:

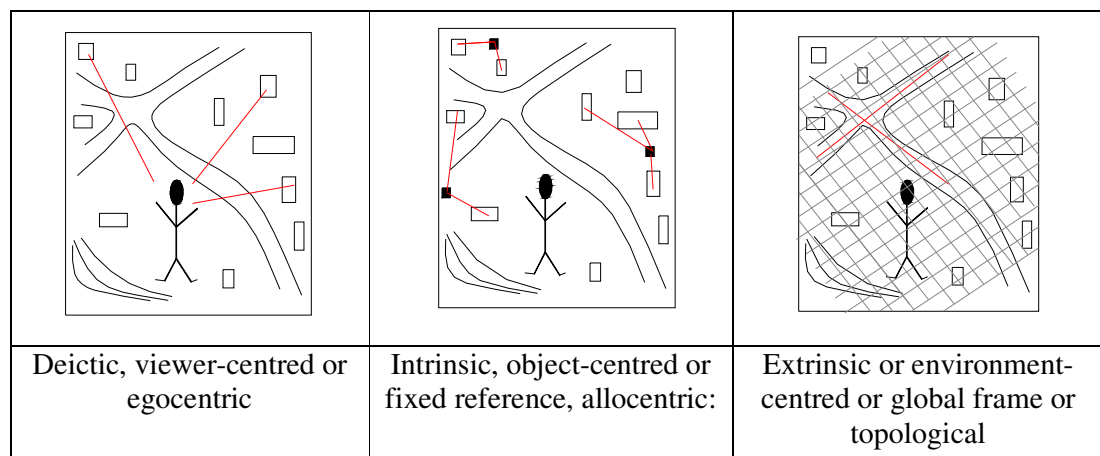


Figure 3.8 - Reference Frames, adapted from Huska-Chiroussel (2000, p: 80)

Taylor and Tversky (1996) pointed out that although this three-part classification is attractive, it is also a source of controversy and confusion. The major objection is that it is difficult to distinguish between a viewer-centred and an object centred framework in a consistent and robust way. Another typical classification is “allocentric frame of reference”, in which its construction heavily relies on the perception of distal cues (refer to Section 3.2) and exocentred frames of reference (centred on the environment), which are characterised by the use of overall representations. They also underlined that “there has been little agreement on which reference frame is the default” (p: 375) and they mentioned that “this lack of agreement suggests that the situation plays a role in determining frame of reference.” (p: 375).

Bryant *et al.* (1992, p: 97) has an interesting idea to explain spatial frameworks. In this approach, “a spatial framework forms a mental scaffolding on which specific information can be arranged and rearranged, information drawn from the world or from a discourse of the world. For the internal spatial framework, the scaffolding is formed from the observer’s body axes and for the external framework from a set of axes projected from the observer.” “The old information serves as a mental hook for attaching new information” (Haviland and Clark (1974)).

McGuinness (1992) reported, however, that the type of model constructed would be dependent on existing knowledge, the scale of the environment, the specific task, and the level of detail required. Liu and Uttal (2000, p: 111) suggested that “given the impossibility of processing all available sensory information people must often search for organization in the environment”. For example, the hierarchical theory of organization implies that small parts of the whole hierarchical array depend, for their meaning, on their membership in larger parts. They are structured as nested level of detail (McNamara (1986). Non-hierarchical theories contend that cognitive map knowledge is structured in a holistic fashion, generic information (based on proposition networks and analog images: Kaplan (1973), Beck and Wood (1976b), Lieblisch and Arbib (1982)) and the use of schema (essential information about places and events derived from past experience: Medyckyj-Scott and Blades (1992)) suggests that new information that falls within an individual's schema is easily remembered and incorporated into their worldview. Similarly, signs that are not organised on the basis of user expectations or pre-existing schemas will “consume cognitive resources and ultimately impair a user’s ability to comprehend and apply the information” (Baddeley, 1986; Baird, 1984; Schneider & Shiffrin, 1977). According to Neisser (1976), “when new information is perceived that does not fit a schema, it simply can be ignore or quickly forgotten. This can happen on a deep level - frequently an individual does not become conscious of or even perceive the new information.” He added that “when the new information cannot be ignored, existing schemata must be changed, in a continuous process of learning and interacting with the environment.”

It appears that there are different levels of acquisition of information, construction of strategy and organization on the development of spatial cognition. MacEachren (1992) suggested that there might be individual differences in processing information. Kitchin (1997) also found evidence for individual differences in encoding strategies. Using a

more critical point of view, Chewar (2002, p: 71) argued that: “people process and understand information differently”; however, most approaches to graphics and interface design seem to construct them based on common features. He suggested that “an adaptive presentation of content, based on principles for accommodating user characteristics would potentially reduce these disparities.”

3.4.3 Environment navigation experiences and external navigation aids: What differences do they make in the acquisition of information process?

In the acquisition of information process, individual will collect information to do his/her journey using experience (through environment navigation) and/or encoded information (through external navigation aids: maps; network diagrams or through verbal interaction etc) and then apply a strategy to organize it, as illustrated by Figure 3.9.

The first consideration imposed in this process is that the interpretation of the information read or listened will require the domain of a language. While listening to verbal instructions or reading written instructions, whether text based or symbolic, analogical or digital, a mental image of what has been read/heard is formed and represented. Then, the user will organise the incoming sensory information spatially (e.g.: route-like or survey type) using one of the mental thinking organization processes (e.g.: hierarchy, non-hierarchy, using schema). Finally, he/she will be able to add the organised information into a bigger base of his/her personal knowledge. Add to this, the ability to make spatial inferences (take short cuts, make detours), the ability to take different perspectives within a particular spatial layout (merge a particular area with another) and the ability to deal with barriers (consciousness of personal restriction and environment restrictions), one has a Personal Cognitive Net: spatial knowledge adapted to individual characteristics. Note that the directional arrows should not imply that cognitive construction moves in orderly steps. The set of processes as explained above is much more dynamic than this simple diagram can express.

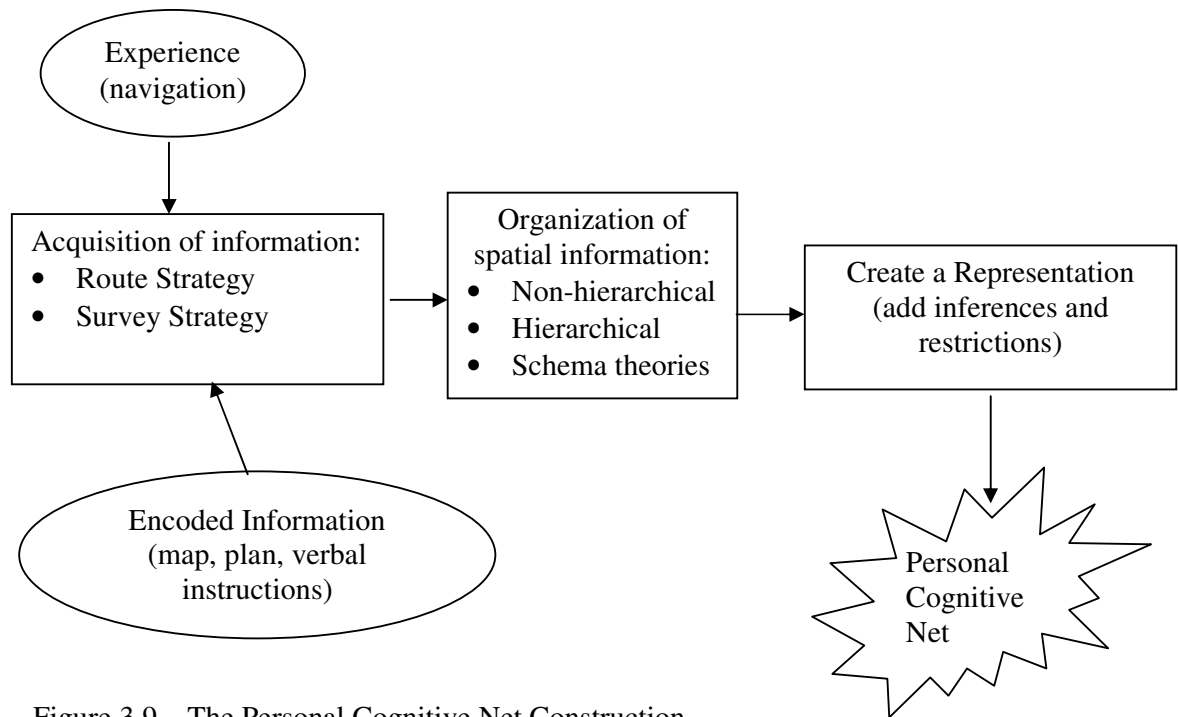


Figure 3.9 – The Personal Cognitive Net Construction

Applied to the specific case of this research (a journey by bus to an unfamiliar area): At the very beginning, only the origin and the destination name might be known. Then both have to be identified (spatially plotted) in some form of schematic representation. However, even if origin and destination were spatially identified, it is quite possible that the person would still not know how to get there. At that point, one theory is that a previous personal schema will be chosen to help this person to reference the new area to his/her previous knowledge. In cognitive terms, doing a journey is like assuming that the user has a previous script, schemata about what they expect to find. Some information from the schemata is gained looking through time-tables, network diagrams, and maps. Other information is gained by asking people around and some is acquired by experience.

Connections will be elaborated in order to attach to the new area what is known or what has been learnt. Schank and Abelson (1977) suggested that the person will merge his/her current location to a point or script he/she knows: physically or abstractly, by practice or in theory, in order to complete the task. Restrictions will be added; a plan of actions will be elaborated. A set of sub-goals during the journey will be created to facilitate the process. A Cognitive Map is formed and it will be updated, confirming or correcting expectations created on the planning phase. Figure 3.10 illustrates the

continuous generation of the Cognitive Map, represented by number [1], which will be run through and during the whole journey.

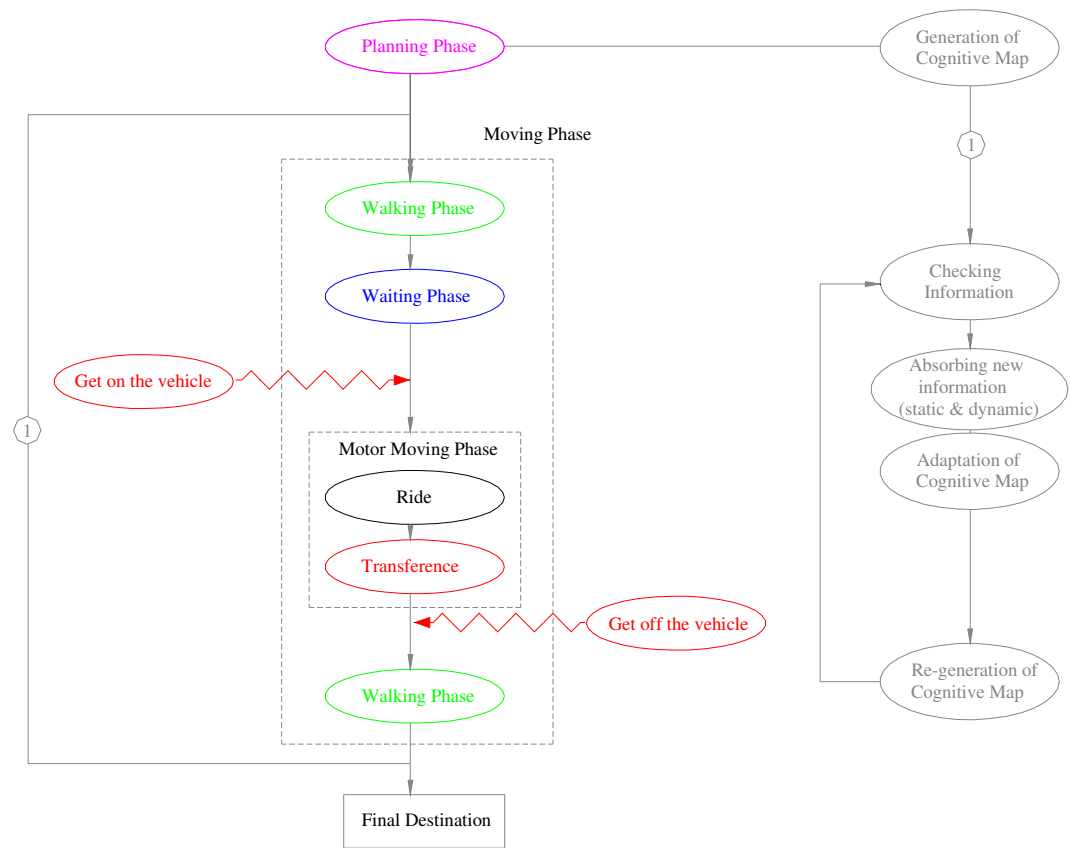


Figure 3.10 – Generation of Cognitive Map and the Phases of a Journey

Related to the updating of the personal cognitive map, according to Held and Richards (1972), individuals can absorb just a tiny fraction of the potential stimuli in the environment. For the visual sense alone, it has been estimated that the environment supplies 10,000,000 units (bits) of information every second and the brain can only absorb 25 units. From a neural function point of view, “neurons tend to code strength of stimulation as frequency, the stronger the stimulus, the more impulses per second” (Gordon 2001, p: 115). Therefore, “an extreme selectivity is exercised in the way the information is extracted from environment” (Gold 1980, p: 48).

Some people can (re)generate cognitive maps very easily, they have a great degree of comprehension and can flexibly create new strategies and update it very quickly and accurately; others are a bit less flexible and find this task difficult: they need more time, repeated experiences and extra help. The underlying philosophy is that a journey needs

to be learnt. In theory, nobody walks aimlessly to go to a specific destination, especially if the time and cost restrictions are added.

The key question here is “how to present such spatial information so as to facilitate particular kinds of organization of knowledge?” (Pick Jr, 1999). Kitchin and Blades (2002) supposed that some forms of learning may lead to different forms of knowledge. For example, researchers who have compared map learning and navigation-based learning have found that maps lead to immediate configurational knowledge and navigation to procedural knowledge. Freundsuh (1991) suggested that although people learning an environment by direct experience might progress from route to configurational knowledge, people learning the same environment from a map can immediately gain metrically accurate configurational knowledge. Levels of knowledge may therefore be a function of the learning medium and, in the case of direct experience, time.

The use of maps (printed maps and screen display maps) is thought to have two effects upon cognitive maps. First, training in map use can provide guidance in how to process and comprehend spatial information. When people have had experience of using maps they can be an important influence on cognitive maps. Second, studying a map can lead to greater knowledge of an area by revealing real world spatial relationships.

Researchers (Herman (1980), Thorndyke and Hayes-Roth (1982), Richardson *et al.* (1999), Smith *et al.* (2000)) have demonstrated that spatial information derived from maps can often be different from the information derived by direct experience. This is because maps show the spatial relationships between all the places represented on the map, but when an area is learnt from direct experience this knowledge has to be constructed gradually. Lloyd (1989a) argued that configurational knowledge learnt from a map may often be more accurate than configurational knowledge constructed from direct experience.

In a particular research study in Public Transport Information Systems, Carmien *et al.* (2005) described information as navigation artefacts provided to help users and stressed that they must be comprehended and manipulated. Table 3.1 described the type and the purpose of each artefact. According to Tufte (1990 apud Carmien, 2005, p: 240), “essential navigation artefacts are often encoded in compact and efficient representations”. He explained that “the representations are compact because different

layers of information are represented in the same small space, separated by the use of colour, shape, texture, and size. These representations are also efficient because they can be universally displayed throughout the system and are easily carried in brochures by the traveller. On the other hand, because of this generality, such knowledge representations create unnecessary cognitive burdens for the user who is only interested in a small fraction of the information presented.”

Table 3.1 – Navigation artifacts in Public Transport (Carmien, 2005, p: 241)

Artifact	Purpose
maps	show spatial relationships between one’s current location and destination; identify routing options; provide an abstract means to assess overall trip progress.
schedules	provide temporal information about route availability at a given day and time.
landmarks	to confirm global progress and anticipate important events or tasks that will come next, such as preparing to get off, etc.
labels and signs	to understand the local environment, including: current location, where to meet transportation vehicles; identify the “right” vehicle; where to get on and off; where to pay; etc.
clocks	to synchronize schedules with physical events, including transportation vehicle arrivals and departures.

Kintsch (1998, p: 174) gave details that “executive function skills (deductive reasoning and logical thinking, which is far beyond mere comprehension) are necessary to understand how to obtain spatial bearings and decode, extract, and remember personally relevant information from these abstract representations.” And Chitaro and Burigat (2005, p: 108) pointed out that “using a map for orientation, for example, implies a significant mental effort (as with a paper map) to switch between the egocentric perspective of the viewer and the geocentric perspective of the map”. Rakkolainen and Vainio (2001, apud Chittaro, p: 2) found that “3D models help users to recognize landmarks and find routes in cities more easily than traditional 2D maps”. Laakso (2003, apud Chittaro, p: 2), on the other hand, found that “3D maps were slower to use both in initial orientation and route finding compared to 2D maps”.

In fact little is known about how different types of information are combined in the cognitive map. There has been little research into how information derived from maps and from direct experience is integrated into the cognitive maps, or why there might be individual differences in this ability.

From the discussion exposed between researchers on the area, two questions arise: What can be extracted from all this to actually put the concepts into practice? And what are the relevant parts of the theory that can be applied to Information System Design for the target group?

The next section explores the specifics of older people and the impact of the ageing process in the functions related to the object of this study: use of information (available in the transport (bus) system of the two city-cases: printed, digital or verbal instruction) to develop a spatial task in an unfamiliar environment.

3.5 INFORMATION FOR OLDER PEOPLE : DESIGN GUIDELINES

As exposed in Chapter 2 (Section 2.6), the issues in ageing that are considered to affect information use in older people are: cognitive decline, gradual vision performance decline, hearing deterioration, odour identification declines and general delays perceptual motor-function and eye-hand coordination.

In terms of cognition decline and the possible impacts in relation to the formation of strategies and information use, the more evident topics are related to working memory and the ability to inhibit irrelevant information. Different researchers list different topics:

- i. “Abilities such as speed of responding and working memory show decline with age and the performance on learning tasks may also decline with age.”(Rogers, 2000, p: 360)
- ii. “Older adults’ performance on episodic-memory tasks is generally lower than that of young adults which might be attributable to age-related differences in the processing of context information.” Bayen *et al.* 2000, p: 131 (For reviews see Craik & Jennings, 1992; Kausler *et al.*, 1984 and Smith, 1996).
- iii. Older adults have difficulties integrating context information with to-be-remembered items (Bayen *et al.* 2000, p: 131). Smith, (1988) pointed out that it appears that older adults do encode and retrieve context information, but that they have problems with the integration of item and context information. However, Vakil, Melamed, and Even (1996, apud Bayen *et al.* 2000, p: 132) reported an absence of age differences in environmental-context effects on recognition.
- iv. Hasher and Zacks (1988, apud Chow and Nesselroade 2004, p: 101) argued that older adults’ cognitive impairments spring from their decreased ability to inhibit irrelevant information. Allen and colleagues (1998a, 1998b, apud Chow and

Nesselroade 2004, p: 101) has some close parallels to the notion of decreased inhibition.

- v. Older adults may tend to rely on general impressions or conceptually driven processing regardless of task relevance, whereas young adults may engage in a more analytical or data-driven approach (Hess, 1990; Hess *et al.*, 1996; Labouvie-Vief & Schell, 1982; Willis, 1996, apud Rousseau and Rogers, 2002 p: 11). But Willis argued that the change could be the result of increased experience over the life span.

Craik and Byrd (1982) developed an important framework to explain cognitive aging effects that relates to the construct of working memory. According to Park (1999, p: 11), “working memory can be conceptualised as the amount of on-line cognitive resources available at any given moment to process information, and can involve storage, retrieval and transformation of information.” “Despite the age-related deficiency in processing resource, Craik and Byrd (1982) suggested that this can be repaired by provision of environmental supports (e.g. signs, announcements) for older adults. Environmental supports are elements of a cognitive task that decrease the processing requirements of the memory task. In other words, although older adults may have a more limited working memory capacity; cognitive tasks can be structured so that they require somewhat less capacity to perform.” (*ibid*, p: 11)

Park and Gutchess (2000) emphasised that although the decline in speed of processing and working memory that occurs with age result in some decrements in performance in everyday behaviours, the decrements tend to be less pronounced than one might expect, or may not be evident at all. There is a wealth of evidence suggesting that older adults perform well when they are performing behaviours at which they are expert or when they are in familiar environments. The impact of cognitive deficits on everyday behaviours is most pronounced when older adults are in unfamiliar environments and must perform tasks that are novel to them.

Reviews in the comprehension of spoken language by Wingfield (2000) have addressed different areas of age-related decline, such as: auditory acuity, capacity of working memory and the rate at which speech input can be processed. The data investigated highlighted important principles:

- i. “Adult aging is often accompanied by declines in auditory acuity that may affect sensory processing for speech” (also reinforced by Fozard (1990); Sanders and McCormick, 1993c). Linguistic knowledge however remains well preserved in

older adulthood. “This combination of areas of loss and preservation leads to a spontaneous use by older adults of top-down information drawn from linguistic context to supplement the impoverished bottom-up signal. This top-down-bottom-up interaction also characterizes natural language processing by younger adults under difficult listening conditions”. Wingfield (2000, p: 191)

- ii. “Older adults can have greater difficulty than younger adults in comprehending speech with structures that place a heavy burden on memory capacity. These include very long sentences, whose comprehension requires memory referents that occurred much earlier in the passage, and sentences with especially high prepositional density or complex syntax.” Wingfield (2000, p: 192)

Consider the implications of these differences for ease of using automated telephone voice menu systems. The longer the message and, in particular, the greater the number of options to be retained in one’s memory, the more difficult are such systems for older users (Sharit, Czaja, Nair, & Lee, 2003).

Park, Smith and Cavanaugh (1990, apud Park 1999, p: 13) stressed that “when designing everyday information for older adults to remember, it is critically important to keep in mind the working memory load associated with material and it is always best to design instructions so that memory load is as low as possible”. According to Seager and Fraser (2007, p: 770), “high levels of mental workload can distract users from other aspects of the navigation task (e.g. planning) and from concurrent tasks or activities. Also, it is likely that users prefer to navigate with minimum frustration and effort.” “Memory cues at encoding, prompts at retrieval and teaching older adults to write down information that they might be likely to forget are important forms of environmental support that can result in good memory.” (Park 1999, p: 13)

The orientation task also places heavy demands on the working memory. Elderly people are much more sensitive to these demands than younger people (Van der Linden & Hupet, 1994 and Bruyas *et al.* 1998). A system that presents information continuously and in a portable manner represents an advantage for this group because they save cognitive resources. Some computerised navigation guides and aides to facilitate navigation can be a powerful tool to help disabled people (PDA - Personal Digital Assistance and mobile GPS systems (see Carmien (2005), Tyler (2007) and Fickas (2008)). However, Fickas (p: 877) also underlined that “while there are increasing numbers of devices becoming available, their designs do not typically consider the needs and abilities of users with cognitive impairments. For example, hand-held devices often place demands on working memory and require holding on to information viewed

in an earlier screen display in order to know how to proceed in a subsequent screen view (Sohlberg *et al.*, 2007).” The rotation/ translation tasks imposed by some devices are also examples of design which might not be good for disabled people, though there are some research improvements in this direction (Seager and Fraser, 2007). Specific studies that take cognitive principles on board seem to be more promising (See (Chittaro, 2005) combination of audio and visual messages and Roger *et al.* (2009) delivering different levels of message according to users' prior knowledge assessment).

Reinforcing the concept of minimum amount of information load, Norman (1988) said: “Because you know that the information is available in the environment, the information you internally code in memory needs be precise enough only to sustain the quality of behaviour you desire.”

There may also be differences in the way that older people and younger people encode the environment. Lipman (1991) found that older adults were more dependent on landmarks (rather than turns) when recalling routes and Evans *et al.* (1982) found that older adults encoded different landmarks and places when compared with younger adults. However, these variations in strategies may not be detrimental to the ability of older adults to form effective cognitive maps. For example, Kirasic (1991) found that older adults' route knowledge in familiar environments was no poorer than that of younger adults, and Ohta and Kirasic (1983) found that older adults were as successful at learning unfamiliar environments. Ohta and Kirasic suggested that, in practical contexts, there is no reason to expect older adults to perform any less well than young adults. Making a similar point, Hunt (1993) argued that even if older people had some slight decrement in their spatial skills, they could compensate for this by their greater general knowledge and reliance on other cognitive abilities.

Another important point derived from studies with automatic processing (Light *et al.*, 1992) suggesting that processes, which were automated when individuals were young, tend to remain intact into older age. That can also explain habits in strategy formation and resistance on acquiring new forms of information. According to van Wee and Dijst (2002), apud Grotenhuis *et al.* (2007, p: 29), “habitual behaviour prevents people from being stressed and makes people use their time and cognitive capacity effectively.”

Rogers (2000) suggested various interesting conclusions from different experiences that might be considered when designing public information systems. They are described in relation to:

- i. “Tasks that require the selection of information on the basis of two or more features will show age-related deficits” (Rogers 2000, p: 59). Madden (1983 apud Rogers 2000, p: 60) suggested that “one method of improving selection of information is to provide cues to minimise search requirements.”
- ii. Wright and Elias (1979) believe that focused attention in older adults remains relatively intact. On the other hand, Hasher and Zacks (1988 apud Park 1999, p: 15) have proposed that “with age people have more trouble focusing on target information and inhibiting attention to irrelevant material. Much of the so called age-related decline in cognition occurs due to the inability of older adults to stay focused on primary information, as they frequently diffuse their attention across both relevant and irrelevant information.”
- iii. If the stimulus is easily discriminatable from the background noise, age differences are minimal.
- iv. Evidence from studies conducted by Somberg and Salthouse (1982 apud Rogers 2000, p: 63) suggested that for simple tasks, younger and older adults can divide their attention equally well. However, for more complex tasks, age-related differences emerge but practice in dividing attention may reduce the age differences.

All the considerations above from the cognitive researchers, through navigation studies and the specificities of the target group highlight several factors that could well be relevant when studying information systems for this target group.

Taking into account:

- i. The basic mental process demanding for the activity proposed (the object of the study: visit a doctor (do a journey by bus) in an unfamiliar area) explained in this Chapter (Figures 3.6, 3.9 and 3.10)
- ii. The extent of information manipulation need during the journey chain (explained in Chapter 2, Section 2.2, Table 2.2 and Figure 2.2);
- iii. The general opinion and concerns of older people about using public transport (also exposed on Chapter 2, Section 2.6) and
- iv. The specific features of older people related to the use of information system, listed in the present section.

A set of information were created for the experiment. Three main aspects were considered:

- i. Information should complement the existing level of information at each environment covering the gaps found during the journey chain;
- ii. Information should aim to support older people alleviating anxiety and reducing cognitive efforts (mainly reducing the use of working memory) during the execution of the journey.
- iii. Information should aim to deliver knowledge about the extent of transport system expanding older people choices.

They are explained in Chapter 4 and illustrated in Annex A.2.

3.6 CONCLUSIONS

This chapter has discussed intricate concepts and different theories about cognition and human spatial orientation. Although different, the lines of research can be said to be incremental and evolutionary, according to the specifics of the core intellectual area in which they were derived (e.g.: geography, psychology, medicine, human-machine interface). Despite the amount of work conducted on spatial orientation, most of the experiments were concentrated in laboratories or, more recently, using virtual environments (computer-generated), and in both cases concentrated on exploring closed or relatively small environments. The tasks tested for each experiment are very specific and very much related to environment cues and individual abilities.

The review shows that there are some general theoretical models to be applied on the case of study but there are not enough agreement among researchers to support the necessary requirements to study the use of information to develop a spatial task in an unfamiliar real environment neither there is a consolidate amount of work to define the relation between information (navigation artefacts) use and spatial knowledge. However, there is evidence that the use of information is mediated by various types of spatial knowledge acquired from different sources and different procedures to make spatial judgements, suggesting that the phenomenon is highly individual.

A schema (Figure 3.6) was suggested using the principles of the modularity approach to support the understanding of individual mental process while planning and executing a real journey. The schema does not aim to deliver any new framework about human cognition or spatial knowledge acquisition. It just sets up the main internal process involved in the construction of spatial knowledge, considered to be important to analyse

the proposed activity: a spatial task in an unfamiliar real environment. Evidence of the lack of consensus about simple definitions and even name agreement were exposed to justify that the INFOChain schema is just a simple base to explain how the specific cognitive processes to complete the activity were linked and understood in this research, and to support how the data will be collected to interpret the important functions demanding while planning and executing a journey by bus in a real environment (e.g.: gathering, understanding, and completing information (retrieve/store and encode to construct a cognitive map) and tracking, comparing, re-evaluate planning and deciding (planning and executing to solve the problem.)). The schema proposed does not intend to be definitive but it guides the emphasis delivered to the experiment tasks which will be detailed in Chapters 5 and 6.

The next chapter describes how the elements of information during each stage of the journey chain are classified and treated in order to be applied in the experiment, which in turn is fully described in chapters 5 and 6.

4 INFORMATION SYSTEMS: REVIEW and TAXONOMY

Chapter 3 introduced different views about the mental process involved in the task objective of this study: the construction of a strategy and the steps involved in the execution of actions to complete a journey by bus. This chapter presents an appraisal of different perspectives for the study of Passenger Information Systems and the type of information currently provided in the two study locations (London/UK and Brasília/Brazil). Additionally this chapter explains how information along the chain will be extracted to analyse individual awareness of Information System.

The first section discusses information systems which incorporate the user's point of view. Section 4.2 justifies the choice of the approach for this research and Section 4.3 introduces the taxonomy to be adopted in this study. Section 4.4 presents the main conclusions of the chapter.

4.1 INFORMATION SYSTEM

Intelligent Transport Systems (ITS) or Advanced Transport Telematics (ATT) are general designations used to characterise systems that incorporate different information systems, such as: Advanced Traffic Management Systems (ATMS), Advanced Traveller Information Systems (ATIS), Advanced Vehicle Control Systems (AVCS), Advanced Public Transport Systems (APTS) and Advanced Rural Transport Systems, among others.

Two important subsystems of ITS have substantially changed the quality of the services in the public transport domain: ATIS and APTS.

The ATIS includes: traveller adviser (e.g.: information about congestion, weather, road incidents), service information (e.g.: information about service, parking, public messages), trip (journey) planning (e.g.: information about schedule, fare, delays, mode, route, departure time), location determination (dead reckoning), route selection (e.g.: information about travel preferences, route guidance (supportive information)) and in-vehicle signs (e.g.: voice and graphic units).

The APTS integrates mass transit systems. Their subsystems consist of: planning and scheduling systems, traffic control and priorities, automatic payment, ride sharing, prediction of arrivals and emergency service. These systems have brought a major change in the quality of information available to the general users, providing them with better quality information more quickly, flexibly and diversely. This approach is said to be consumer-oriented as a means of increasing bus systems productivity.

A slightly different approach focused on the promotion of the information is described by Turnbull *et al.* (2003). They divide the system into six categories of information and promotion: Mass Market Information; Mass Market Promotion; Targeted Information, Targeted Promotion; On-Going Customer Information and Real-Time Transit Information. Targeted promotions aimed at persons in the service area of particular transit routes or facilities but the overall emphasis still is to increase “ridership” and “net revenues”. Targeted promotions in the United States and Canada have resulted in ridership increases of 2 to 50 percent. Table 4.1 describes the concept worked out for each category.

Table 4.1 – Turnbull Information System Classification

Category	Concept	Examples
Mass Market Information	General information about transit services. Provision of basic level of information about transit system and are intended to develop awareness of the various service available.	Brochures, system maps and ongoing customer information services including informative bus stop signs, telephone information and websites.
Mass Market Promotion	Extra incentive to try transit	Route or sector specific maps and schedules
Targeted Information	Directed to individual market segment	Residents in a certain area or along a specific route, commuters in specific corridor
Targeted Promotion	Incentives are made available only for the desired group	Free or discount riders
On Going Customer Information	Designed to provide individual members of the public with the information they need to use transit services in an area	Bus stop signs, telephone information and websites providing routing scheduling and fare information
Real-Time Transit Information	Advanced Traveller Information Systems (ATIS)	Interactive computer information via changeable message signs

A different approach is defined by studies that take into consideration accessibility issues from the beginning of the process (e.g. Ackerman (1995), Hackney Plusbus, Lynas (1997), Cumbria Plusbus, Brown and Tyler (2002), Legible London, AIG

(2007)). They take the users' point of view as the centre of the design, dealing with different types of users, including disabled people. They consider that Information Systems are designed to support users' decision-making. They tend to incorporate the cognitive principles into the analyses (search/acquire/assimilate process or select/process/use of information), meet directly the thoughts of accessibility issues. They also tend to consider the physical and social features of the environment. The types of question treated are, for example: Can the users understand the information? Is the current level of information good enough for users (for example older people) to plan and execute the journey? Is the available information good enough for user to cope with eventualities in the real world? Can the activity be completed with the current level of information about environment features?

To answer such types of question it is necessary to change the objective behind information provision from increasing patronage and productivity or improving efficiency to minimise the effort for the user in acquiring information and to expose the user to information on such options, such as proposed by Kenyon and Lyons (2003), for example. Or to ease understanding, orientation, searching and planning reducing cognitive effort, as suggested by Grotenhuis (2007). Or simply understand how people use information, as proposed by this study.

Among the studies about Information Systems which focus on the user's view and incorporate accessibility issues for pedestrians/passengers, one particular classification was developed by Ackermann *et al.* (1995) who introduced a division between the Information System and the Orientation System, already explained in Chapter 2 (see Section 2.2).

In terms of content, Ackermann's view is that the Information System consists of traditional (mostly printed) types of information provided by operators and public transport planners: (e.g.: Timetable Figure 4.1 and Route diagrams, Figure 4.2 and 4.3 in Table 4.2). The Orientation Systems are relatively new, some examples can be found in urban centres where the walking activity is stimulated such as: in the UK (Figure 4.7) in France (Figure 4.8), and in Germany (Figure 4.9), but they remain rare for the majority of cities, especially in South America. Orientation Systems work as a confirmation and support of the moving phase along the Journey Chain. Table 4.2





Table 4.2 – Examples of Information Systems for Bus Systems

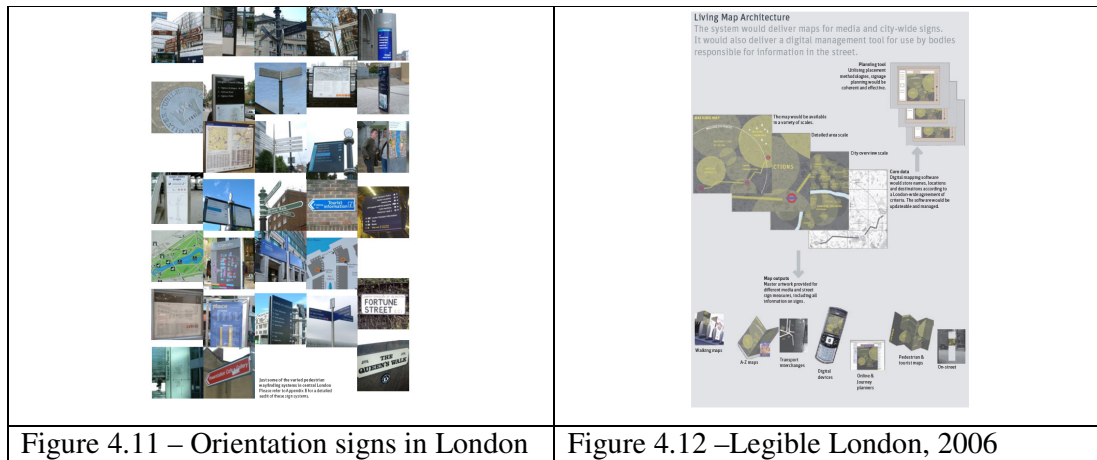


Looking at the Orientation Systems, the initial examples presented in Table 4.3 (Figure 4.7, 4.8, 4.9 and 4.10) neither conform to the original Information Chain concept set by Ackerman (Table 2.1, Chapter 2) nor to the adapted Information Chain concept proposed by Caiafa and Tyler (Table 2.2, Chapter 2) – the flow of information, meaning consistent and easy integration between information and orientation systems. In practice, the Orientation Systems seem to be treated in isolation and fixed where needed. Consistency is not observed in the treatment, as a system should be, and some are not customised for public transport/pedestrian users, but for drivers (e.g. Figure 4.10).

On the other hand, it is observed that there is an increasing preoccupation in improving ‘Walking’ as an efficient mode of transport, particularly in London. Conceptual studies such as The Walking Plan for London (TfL, 2004), Improving Walkability (TfL, 2005), Legible London (AIG, 2006, see Figures 4.11 and 4.12) and its practical piloted studies in different pedestrian environments (TfL, 2008a) are very important documents and will deliver consistent orientation systems in the near future and consequently will help to improve the use of public transport.

Table 4.3 – Examples of Orientation Systems

	
<p>Figure 4.7 – Orientation sign to Hospital in UK (London, 2006)</p>	<p>Figure 4.8 – Block map in France (Paris, 1999)</p>
	
<p>Figure 4.9 – Tactile surface inside station, German (Liespsaizk, 1999)</p>	<p>Figure 4.10 – Orientation sign to Hospital in Brazil (Brasília, 2006)</p>



The main idea of the Legible London project (Figure 4.12) was to break London into a series of village sized nodes to reduce the spatial barriers. Information is provided in 6 potential levels: nodes (node maps: 2-3 minutes walk), places or neighbourhoods (sub-area map: 5 minutes walk or 400m), villages (area map: 10-20 minutes walk), areas (zone-map: 20-40 minutes walk) and another two levels (multi-zone map: 40 minutes walk) and (overview map: 80 minutes walk). The hierarchical approach solution consists of an integrated and standardised system which is consistent but flexible for scale and use, such as:

- i. Node supporter: simple information that enables pedestrians to set off in the right direction from stations, visitor attractions and other entry points into the wayfinding system.
- ii. Area supporter: A simplified street map showing the relative position of surrounding areas, with information about key destinations (e.g. “Bloomsbury for British Museum”). These signs are key in helping people develop their own mental maps;
- iii. Path supporter: Street maps along the route confirming the direction and side routes that connect into adjacent neighbourhoods;
- iv. Homing beacon: Finger posts close to major destinations, showing the average walking time from that point. Nevertheless, homing beacons have an important part to play in London, where major destinations are often obscured from view. The British Museum is famously tucked away. Trafalgar Square is not visible from Charing Cross Road until you’re almost there.

The pictures are isolated examples. Some of them are simple and useful operational information, such as London’s route diagram and timetable (Figure 4.1) in which the stops are just named in sequence on a straight line. Some are more sophisticated giving users useful clues about the environment (Route diagrams found in Paris, Figure 4.2). Another good example is the spidermap in London (Figure 4.3, where common

segments of different line services are presented by local bus stops). But others are not appropriate for user's needs (Timetable in Brasilia, Figure 4.5), there is no indication of the route in space and the letters used are very small. In general, they reflect the state of the art and importance public transport (and particularly the public transport information) has in terms of public policies. Specific discussion about the two city-cases public transport policies and practical developments are presented in Chapter 7 and 8, London and Brasilia, respectively.

It is worth clarifying the components of Information Systems which are strongly related to the way users assimilate information, as suggested in Chapter 3. According to Suen's classification (1986), the three basic components of all information are: contents, form and media. Figure 4.13 illustrates information components

- i. Content is primarily what is being expressed; it is the character of information, the message. There are several levels of information depending on the purpose of the information and tends to dictate its function: general, specific, and operational.
- ii. Form (or format) is the method of presentation: the design and the arrangement of the basic elements of the message. It can be abstract (e.g.: illumination, colour), symbolic (e.g.: shapes, pictograms, sign) or literal (e.g.: text, human speech).
- iii. Media is the location and method of conveyance of the message. It is the interface, channel of communication between operator and user. It is differentiated by the level of interaction: passive or static media (printed), active (sign and audio signals – although it can also be passive) or interactive (personal interaction in which the user can interrogate).

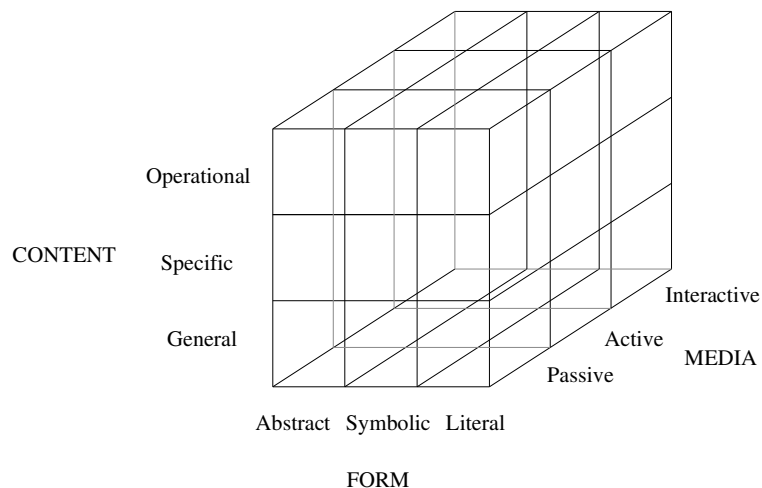


Figure 4.13 – Information Components, according to Suen's Classification (1986, p: 290)

In practical terms and considering public transport particularities, it is necessary to guarantee that the information can be assimilated for all types of users. Thus one question still remains: Can an information system help in the construction of the representations that will lead to a set of individual decisions to be put in practice? Or in other words: Can an information system help the construction of spatial representations used to navigate in order to achieve the destination and complete the activity? And can everybody make use of it?

Another example of a system oriented to help users in the wayfinding process is “The Transit Trip Model” developed by TCRP (1999, Report 12) which describes the hierarchical steps of wayfinding. Table 4.4 illustrates the designed process used for a regional transport system.

Table 4.4 - Wayfinding Design Steps for a Transit System

Principles of wayfinding	Wayfinding Design Steps	Examples
High Order Decisions	Total trip	Plan the total trip on the system or between systems
Mid-Level Decisions	Trip segment to trip segment	Locate sites/facilities Locate entrance/exits to sites
Low-order Decisions	Trip segment within a site	Connect entrances, primary functions and exits
Decision Execution	Decision points between segments	Identify and locate architectural features and signs
Information Processing	Signage content/location Legibility/readability Size/spacing Contrast/colour	Design architectural features and sign message

The classification adopted in Table 4.4 demonstrated some concern in relation to what needs to be represented according to a pre-defined decision levels (“Wayfinding Design Steps”) and principles of wayfinding. For example, at ‘mid-order level decisions’ the emphasis is in the ‘trip-segments-to-trip-segments’ (which corresponds to the interfaces between the stages, in INFOChain). There is a pre-classification of the objective of the information provision, following the wayfinding principles, so the design of the information is customised to cover this objective: e.g.: the information piece produced locates sites and facilities and locates entrance and exits to sites (emphasizing the interfaces between stages, e.g.: how one gets off a bus and immediately knows where the bus stop is in relation to the next stage, the walking direction to the destination point).

The different classifications adopted in each study are closely related to the objectives to be demonstrated by the conceptual model behind it. While it is considered very important to target the group to increase the use of public transport (ridership and net-revenue, Turnbull *et al.*, 2003) and to tailor the information to the public it is designed to (TDRP, 1999) it is also important to verify the “real use” of the information provided to the target-group (accessibility of the system or how easy is to use the system) in real environment conditions.

The present study concentrates primarily on the content of information provided in the bus system (or created for specific purpose of the experiments), treating the second component (the form) as an output of user’s selection of information. That means the analyses focus on the message (itself) that aims to help people make decisions about how to complete the activity. However the third component, media, cannot be completely ignored and references are added when considered relevant to the discussion.

4.2 THE CHOICE OF PERSPECTIVE - INFOCHAIN APPROACH

The type of the information analysed in the present study follows the concept tailored by Ackermann (1995) extending the original notion of information and orientation systems (information piece used along the journey chain, Table 2.1, Chapter 2) into a set of subtasks an individual needs to do in order to complete a stage in the Journey Chain, explained by Caiafa and Tyler (2002b) (Table 2.2, Chapter 2).

The information taxonomy borrows ideas of psychology and cognitive science (presented in Chapter 3) to expand the domain of information. An ideal user has a global view of the journey as a chain but looks at the intermediate subtasks in a serial manner, acting locally. The idea is therefore to decompose the complex task into multiple simpler ones by gathering information about the set of subtasks needed to complete each stage of the activity (e.g.: the bus-related portion of a journey to a hospital) according to individual needs in a given environment.

The concept of the Information Chain, was introduced in Chapter 2 (Section 2.2, Figure 2.2). Figure 4.14 emphasises the main function of information along the Journey Chain. there is a specific purpose and this is transformed by the subtasks/attributes (detailed on

Table 4.6) which the user will evaluate (according to the knowledge of his/her individual capability and the knowledge about the available environment capability) into the determination of the need (or not) to obtain the information. He/She will then decide whether or not to select the information to process the plan and the execution of the journey.

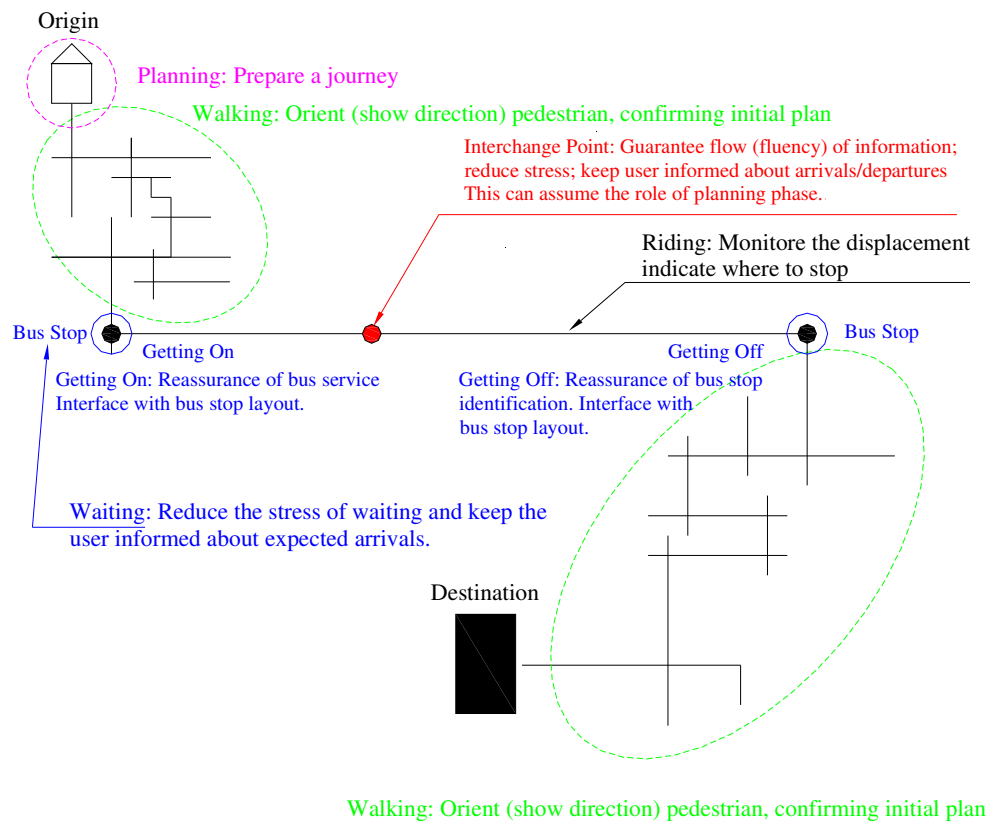


Figure 4.14 – Information function along the Journey Chain

More details about the physical demands of the two distinctive processes added ('Getting On' and 'Getting Off') can be found in cooperative research between London Underground and University College London (UCL) (2007) and Department for Transport and UCL (2008).

Figure 4.15 illustrates different situations in which information can be captured. This can be via a formal inspection (e.g. a timetable at a bus stop) or informally absorbed (via proximal cues from environment). In addition it is necessary to consider the

different media by which the information can be represented (static/passive and dynamic/active and interactive).

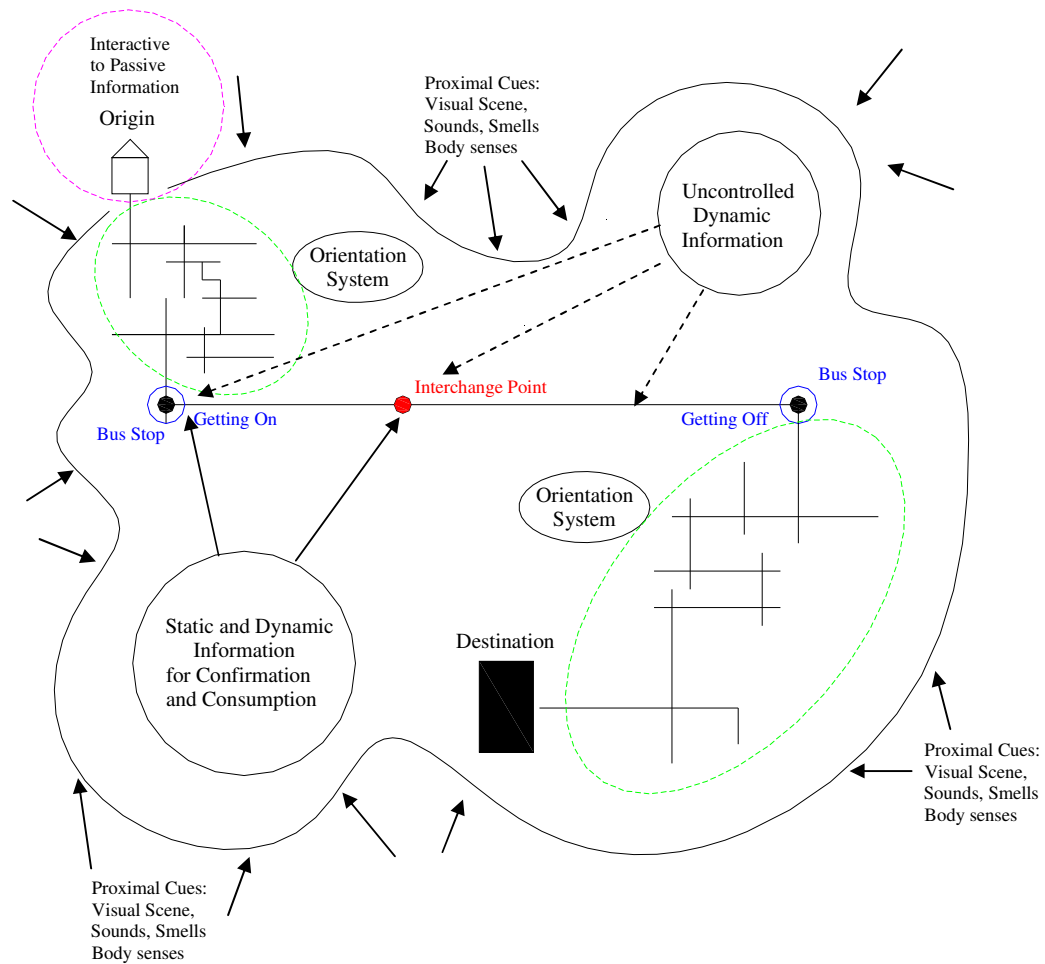


Figure 4.15 – Flow of Information along the Journey Chain

According to Suen (1986), communication of information can be with or without the need for the passenger to interact: in passive media, the medium provides static or open communication with no facility for feedback or interrogation and the information is conveyed in the same way to all users (e.g. a printed timetable at a bus stop). In active media, the medium is more dynamic but still open (without scope for feedback or interaction) but allows for broader content (e.g. real time bus arrival information at a bus stop). In interactive media, the medium is dynamic and closed and provides the user with the opportunity for feedback and interrogation (e.g. ‘discussing’ alternative routes given the current state of the bus system). Suen emphasises that “while the possibility for interaction makes dynamic information more expensive, it allows the passenger to determine whether the information is clear and complete and meets their criteria.” Suen (1986, p: 295). There are no distinct divisions between these media and they can be seen

as merging with each other across a ‘dynamism spectrum’, an example of which is shown in Figure 4.16.

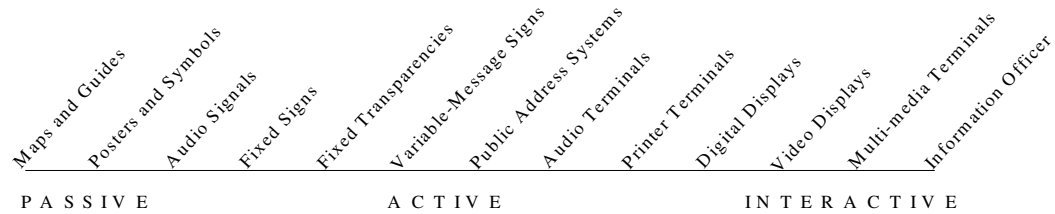






Figure 4.16 – Media for Public Transport Information (Suen & Geeham, 1986, p: 296)

Figure 4.15 illustrates the different types of information (media) that could be available along the journey. In the planning stage, interactive information such as Journey Planner or, even a telephone service, would help. During the movement stage users will add cues from the environment via their senses. Orientation systems during the walking stages can support users and reduce cognitive and affective effort (“the emotional energy expended during the journey, caused by dealing with the uncertainty”, Stradling *et al.* (2000b) and Stradling (2002) apud Grotenhuis *et al.*, 2007 p: 30). Static and Dynamic information for consumption and confirmation at a bus stop can also reduce uncertainty (e.g. arrival at intermediate stops and final destinations) and information oriented to deal with uncontrolled and dynamic information such detours, cancellations, emergencies can be especially useful for disabled people.

In principle, the more examples of information content and media one can find along the journey chain, the easier would be the journey. In practice, studies such as Legible London demonstrate that the simple presence of information is not sufficient to help people to move and complete their activities because the system needs to be integrated and consistent; information has to be presented in a harmonious way, matching the functions as illustrated in Figure 4.14. Information and orientation systems have to deliver the connection between different types of spatial concepts. They need to present the connections (that are not evident) into a consistent form using, for example, the notion used by Legible London (2007) (node supporter; area supporter; path supporter) or by Paris Bus Stop Information (1999) (e.g.: where information about: the bus stop area (local area) are close to the bus services (micro area) which is close to the Paris bus network (macro area)). The notion of continuity and navigation through the different dimensions of space needed to be embedded into the system.

Table 4.5 complements Tables 4.2 and 4.3. It presents the main sort of electronic devices to deliver supportive information in different stages of the journey.

Table 4.5 – Electronic Devices to deliver Information in Different Stages of the Journey

<p>Public Interactive Terminals (sometimes called "Information Kiosks") are very often located near public transport (PT) network facilities, in stations or at stops. Two kinds of information can be accessed: <i>travel information</i> such as optimum route, description of itineraries, how to access the other points of the PT network, etc.; <i>general information about city activities (cultural, commercial, sport, public events...)</i>. Some of these terminals are said to be "intelligent" and interactive to varying degrees, include ticketing machines. The main goal of such information systems is to help the traveller mainly before a journey or in some cases during the same journey at connections to plan a trip. (http://www.ul.ie/~infopolis/scope/kiosk.html)</p> <p>Journey stage: reassuring the planning stage</p>	 <p>Figure 4.17 (verizon.mediaseed.tv/story.aspx)</p>
<p>Personal devices – mobile phone integrated with satellites displaying different types of information from internet service: e.g. emergencies or faulty services warnings, connections and standard bus service.</p> <p>Journey stages: variable</p>	 <p>Figure 4.18 (apeshop.com.au)</p>
<p>On board information – digital display inside buses, informing next bus stop name</p> <p>Journey stage: 'riding stage'</p> <p>Picture taken from inside a London Bus by the researcher.</p>	 <p>Figure 4.19</p>
<p>Countdown system – digital display device fixed at bus stops informing bus service number, destination and waiting time.</p> <p>Journey stage: 'waiting stage'</p> <p>Picture taken in Central London by the researcher.</p>	 <p>Figure 4.20</p>

In the scope of the INFOChain study, the use of personal mobility devices (see Chapter 2, Section 2.1.1) is not investigated because the technology is neither available in

Brasília to the specific target group, nor is it fully used in London. In their survey, Baker & Kim-Sung (2003) showed that only 27% of persons 65 and older had a mobile phone service, compared with 50% of persons 50 to 64 and 55% of persons 18 to 49. None of the participants in the present study presented themselves with digital mobile technology that might support them in the execution of the activity (e.g.: spectacles, cane, frame).

The specific information delivered by ‘iBus’ system, currently (in 2009) available on all buses in London, was not implemented on the bus services studied at the time of this research exercise (May/2006).

4.3 INFOCHAIN TAXONOMY

According to the INFOChain approach there is a set of information an individual theoretically needs to capture in order to complete each stage of the activity. These are illustrated in Table 4.6. As illustrated by Figure 4.14, the INFOChain Methodology divides the Moving Phase of the journey into 7 stages. The actual implementation of each subtask (the collection of information that will support advance to the next stage) is related to the result of the interaction between the individual capability (provided) and the environment capability (required). Three types of information were adopted in this study:

- [E] Essential: the indispensable information to complete the subtask. The content can be general (e.g. location) or operational (e.g. route)
- [T] Time: imposed by INFOChain experiment constraint and
- [AI] Accessibility Issues: supportive type of information that can turn into the Essential type depending on tradeoffs between individual and environment capabilities.

Although Cost [C] would be an extremely important type of information for any consideration about public transport systems, the target-group of this study in both environments (London and Brasília) is eligible to free travel and the natural cost-constraint, which is intrinsic for most users of the transport system, is not felt by the group. Therefore “cost” will not be formally treated in this methodology. The only stage where cost appears is the ‘Getting On’ stage and it is treated as an Essential type of information (i.e. cost = acknowledgment of free pass).

Table 4.6 – INFOChain Subtasks Definitions

#	Stage	Subtask/Attribute	Type	Definition
1	Walk O	Path Identification	E	Collect information to localize and plot the path between Origin and Bus Stop, including direction and landmarks
2		Distance to walk	T	Estimate distance in length unit or time unit
3		Footway Conditions	AI	Any reference about regularity of footways
4		Crossfall	AI	Any reference about inclination of footways
5		Crossing Points	AI	Any reference about type of crossing point features
6		Barrier Identification	AI	Any reference about physical barriers
7		Safety Issues	AI	Any reference about risk, illumination, isolation
8		Orientation signs	AI	Any reference about existence of signs or pictograms
9	Wait	Bus Stop Identification	E	Location or name of bus stop
10		Bus Stop layout	AI	Any reference about design of bus stop area/platform
11		Safety issues	AI	Any reference about risk, illumination, isolation
12		Waiting environment	AI	Any reference about support at bus stop area
13		Waiting time	T	Estimation in minutes/frequency
14	Get On	Gap Negotiation	AI	Any reference about vertical/horizontal gaps
15		Bus Service Identification	E	Bus number or 3 point-route
16		Bus Type	AI	Any reference about low floor/ wheelchair
17		Cost	E	Tariff/Price/Free-pass/Oyster Card
18	Interchange	Gap Negotiation	AI	Any reference about vertical/horizontal gaps
19		Bus Stop layout	AI	Any reference about design of bus stop area/platform
20		Path Identification	E	Collect information to localize and plot the path between Bus Stops, including direction and landmark references, crossing point
21		Bus Service/Bus Stop Identification	E	Bus number or 3 point-route
22		Time wasted at interchange	T	Estimation in minutes of walking+ waiting
23		Safety issues	AI	Any reference about risk, illumination, isolation
24	Riding	Landmarks References	E	Any reference about name of places, buildings or description of geographical issues
25		Direction	E	Euclidean, R/L or a well known place reference
26		Distance	T	Estimate distance in length unit or time unit
27		Bus Design (Keep stability inside bus)	AI	Any reference about interior bus design
28	Get Off	Landmarks References	AI	Any reference about name of places, buildings or description of geographical issues
29		Bus Stop Identification	E	Location or name of bus stop
30		Gap Negotiation	AI	Any reference about vertical/horizontal gaps
31		Bus Stop layout	AI	Any reference about design of bus stop area/platform
32	Walk D	Path identification	E	Collect information to localize and plot the path between Bus Stop and Hospital, including direction and landmark
33		Orientation signs	AI	Any reference about existence of signs or pictograms
34		Distance to walk	T	Estimate distance in length unit or time unit
35		Footway Conditions	AI	Any reference about regularity of footways
36		Crossfall	AI	Any reference about inclination of footways
37		Crossing Points	AI	Any reference about type of crossing point features
38		Barrier Identification	AI	Any reference about physical barriers
39		Safety Issues	AI	Any reference about risk, illumination, isolation
40		Target (Hospital) identification	E	Location, description, landmark or pictures of Hospital scene

Different stages have different types of information goals. Definitions of the set of subtasks necessary for each stage, presented in this study, were based on a previous study about accessibility issues in bus systems (Caiafa and Tyler (2002b) and a set of pilot experiments (conducted in 2004 and 2005, details in chapter 5) developed to construct the Methodology of INFOChain.

In the ‘Walking to Bus Stop’ stage it is essential to identify the path from the origin to the nearest possible bus stop. Estimation of distance (or time) refers to time information. Footway condition, ‘crossfall’, features of crossing points, barrier identification, safety issues (e.g.: lights, isolated areas) and presence of orientation time are considered in this study as information about accessibility issues, a type of information constantly demanded by older people in their preference declarations (DETR (2001).

Bus Stop identification is essential information for the ‘Waiting’ stage - the correct identification of the place to wait for the bus. The layout and the environment as well as the safety issues make the accessibility issues category. Waiting time forms the time constraint.

In the ‘Getting On’ stage, the first important information is to certify that is the correct bus and have money to pay the ticket (having the pass ready to show driver, in older people case). Knowledge about the type of the bus (low floor or adapted to wheelchair users and the correspondent mechanisms to operate it) and gap negotiation constitute the accessibility issues. The gap negotiation is a function of four basic components: bus stop design, bus type, driver skill and person’s capability, provided that the disability awareness training¹⁸ was already settled. A detailed study about the importance of gap negotiation was developed by Tyler and Caiafa (1999).

The essential information for the ‘Riding’ stage is to know one is going in the right direction. Landmark references are essential portions of the information needed to compose the cognitive map. Distance or time estimation composes the time restriction and reassurance about the internal configuration of the bus is related to the accessibility issue of stability inside the vehicle.

¹⁸ Disability Awareness Training: A generic training framework, applicable across all transport modes (DPTAC/DfT) to enhance the quality of assistance received by a disabled person. (<http://www.dft.gov.uk/transportforyou>, November 2009)

In the ‘Getting Off’ stage the essential information is to know where to get off. Landmark references help to identify where the alighting point is located as the bus approaches it. Gap and bus stop layout constitute accessibility issues and are related to the actual act of getting out of the bus, which is considered to be more difficult by old people (source) than the boarding process (DETR, 2001).

In the ‘Walking to Hospital’ stage the attributes are basically the same of walking to bus stop stage. However the priority seems to be altered. The final target identification constitutes the last essential information item to complete the journey.

Interchange is characterised as a condensed journey chain where the essential information needs to be captured very quickly. For Abdel-Aty (2001) and Lyons and Harman (2002) apud Grotenhuis *et al.*, 2007 p: 28), “interchanges are perceived as a barrier to using public transport”. It essentially begins immediately after one gets off. The next essential information is to know where to go: the path identification to the next bus stop. Next come the bus stop identification itself and the service to be used. Time wasted at the interchange can be considered a time restriction but in fact it is an outcome of how well prepared the plan was and is considered in this study as an element of the quality of the user’s plan. Gap negotiation, bus stop layout and safety issues around the interchange point are important examples of accessibility issues type of information.

Table 4.6 presents the 40 attributes (or subtasks) considered in the Journey Chain concept. In the next sections the complete set of information pieces (e.g.: timetable, A to Z, Spidermap) provided by the public transport system for each city is presented (Table 4.7 for London and Table 4.10 for Brasília). Each piece of information will be evaluated according to the 40 attributes chosen and will assume values that can vary between 0 and 1, which constitutes the data unit (elementary information) that each piece of information can deliver (See Tables 4.8 and 4.11).

The next section presents the current state of information provided by the transport sector in each city: London and Brasília. It starts with a brief view of the two environments, presenting the accessibility conditions and the set of information available to support the respective bus systems at the time of this study (London (April-May/2006) and Brasilia (September-October/2006)).

4.3.1 Information Systems in Real Life Conditions

In real life conditions the flow of information is less comprehensive than the ideal situation exposed by figures 4.14 and 4.15. The pattern (conditions) found in London and in Brasília is presented in subsequent sections.

4.3.1.1 London Environment

London is the most populous city within city limits in the European Union with an official population of 7,172,000 (on the latest Census Day of April 2001). It has a metropolitan area population of between 12 and 14 million people.

The administration of London takes place in two tiers — a city-wide, strategic tier and a local tier. City-wide administration is coordinated by the Greater London Authority (GLA), whereas local administration is carried out by 33 smaller authorities. The GLA is responsible for strategic planning, policing, the fire service, most aspects of transport and economic development.

Transport for London (TfL) is a local government body responsible for most aspects of the transport system throughout Greater London. The role of TfL is to implement the Mayor's Transport Strategy and to manage transport services across London. London Buses is the subsidiary of Transport for London that manages bus services within Greater London. Over 6,500 scheduled buses operate on over 700 different bus routes calling at over 17,500 bus stops. Over the year this network carries over 1.5 billion passenger journeys (TfL, 2008).

In terms of Accessibility, London can be characterised as an accessible city. Although underground and rail stations are not fully accessible the bus system has experienced an immense transformation in order to provide accessible service to all parts of London. The bus network is under revision with the objective of becoming more integrated with rail and underground services (Iman, 2007). The fleet is fully accessible, meaning served by different types of low floor buses (step-free floor). Although at the time of the experiment the information system inside vehicles needed lots of improvement in relation to dynamic information during the 'Riding' stage of the journey, the 'iBus' real-time location and passenger information system has since been introduced across the entire fleet (in 2008). Bus stops are the weakest link in the chain: most of the bus

stops are inaccessible and incompatible with the low floor buses, generating huge horizontal and vertical gaps that cannot be overcome by disabled people, and represent the biggest single barrier in the system. More details with pictures can be found in Annex A1 – Part A: London's Environment.

In terms of information, together, the pre-trip information system Journey Planner (interactive computer-base system oriented for the planning stage) and the Countdown system (dynamic information delivered at the bus stop, providing the predicted arrival time and the service line of forthcoming buses during the waiting stage) guarantee high levels of information provision. Journey Planner offers information to prepare a journey to an unfamiliar destination, integrating all modes and incorporating disability awareness issues to act as a refined search for a specific journey. Nevertheless it is only accessible via the internet, so users have to be familiar with computers and the internet as well as the Journey Planner system itself. However, nowadays, very good qualities of printed materials are available at London Underground and London Bus stations ('Where to get my bus', 'Area bus guide' etc) and at most bus stops ('spidermap', timetables, bus services list, local area map etc). See Annex A1, Table A1.1 to A1.3.

The on-bus passenger information display and announcement system – 'iBus' London supports the flow of information throughout the riding stage of the journey. Trials were implemented in December/2005, on 5 (five) buses on route 149. The technology is now consolidated on 8,000 buses and 90 garages across London, informing passengers of every stop on the way both visually and audibly (<http://www.tfl.gov.uk>, accessed in November, 2009). See Annex A.1, Table A1.5

Although London can be considered to be a reasonably accessible city which provides good and accessible levels of information for bus users, the orientation system needs improvement and this topic is under review with some excellent perspectives. Legible London is the project currently being undertaken by TfL/AIG/Central London Partnership, in which the main objective is to identify a common solution to wayfinding and to outline the principles of a pedestrian signage system that encourages walking, takes into account different kinds of walkers (residents, visitors or commuters) and makes London easier to understand for pedestrians.

In recent research undertaken by TfL (2006-2009) it was highlighted that more attention needs to be paid to the provision of travel information for disabled people, both to help them plan journeys and to reassure them while en route. The problems with information provision for people with disabilities seem to be related to the presentation of information, and occasionally the lack of information suitable for people with specific disabilities, rather than the accuracy of such information.

Table 4.7 illustrates the level of information available to support the current bus system in London. There are 18 different pieces of information covering general to operational information. The general information is the available information piece that can be easily bought at newsagent or shops (e.g.: as A to Z, web-street maps). The information provided is created and distributed by the Local Public Transport planners (in London by TfL + operators). They constitute the operational level of information, such as timetable, detailed stopping points and routes). A few of them deliver aspects of accessibility.

Information pieces for each environment are presented in Annex A1 – Experiment Environment and Information Features.

Table 4.8 describes each piece of information covered by the London Bus Information Systems in relation to the E, T, and AI information types adopted in this study (as outlined in Section 4.3). In Table 4.8, the content of information provided by each information piece is classified as:

- i. [1] if it fully covers the attribute in question or
- ii. [0.9 to 0.1] if it partially covers the attribute in question. In practice it was used 0.5 when the information was partially covered and 0.2 when the information can only be inferred;
- iii. [blank] if it is not covered at all.

The max-column registers the maximum value between all the 18 types of source of information for each subtask. The total coverage of the journey chain is: 22.3 (11 covering E-Type, 5 covering T-Type and 6.3 covering AI-Type or in %: 49.33%, 22.42% and 28.25%, respectively). Some subtasks (e.g.: safety issues, distance to walk) are covered by different types of information, some are completely uncovered (e.g.: crossfall, bus stop layout).

Table 4.9 totals the percentage of each of these classifications for each category E, T, AI. The percentage for each type of information in London provided by the current bus system is: 66.6% for Essential information, 20.4% for information related to Time and 13.0% for Accessibility Issues.

Table 4.7– Information provided by Transport System in London

#	Title of Information Presented to Participant	Brief Description	Type	Status
1	A to Z or Easy to Ride	Map of streets and tube station	General	Available
2	Hospital's Website	Webpage with general information about the hospital including public services to get there	General	Available
3	Street Map Website	Digital map on web	General	Available
4	Map of London Buses	Bus line service on a map background	Operational	Available
5	London by Bus		Operational	Available
6	Area Bus Guide		Operational	Provided by TfL
7	Telephone Information System	Oral conversation which provides the service line and location of bus stop for a particular pair O/D	Operational	Provided by TfL
8	Journey Planner	Interactive Digital Information	Operational + AI	Provided by TfL
9	Local Public Transport Map	Bus line service on a map background	Operational	Provided by TfL
10	London Map – Bus Map & Guide		Operational	Provided by TfL
11	Spidermap	Schematic diagrams of line service per bus stop area	Operational	Provided by TfL
12	Timetable	Origin and destination with schedule	Operational	Provided by TfL
13	Bus Service from Underground Station	Location on bus stop on map area related to tube station	Operational	Provided by TfL
14	Continuing your journey from	Alternatives of integration related to tube station	Operational	Provided by TfL
15	Bus Stop Sign	Line services numbers	Operational	Provided by TfL
16	Countdown	Electronic device installed at bus stop showing the number and destination of the bus and waiting minutes	Operational	Provided by TfL
17	Fare Costs	Price per journey type	Operational	Provided by TfL
18	Type of Vehicle	Symbol of wheelchair	Operational + AI	Provided by TfL

Table 4.8 – Information coverage by Bus System in London

	#	Content of Information		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	max
W A L K O	1	Path identification Information	E	1		1	1	1	1	0.5	1	1	1				0.5					1
	2	Distance (time) to walk	T	1		1	1	1	1		1	1	1		0.5		0.5					1
	3	Footway Conditions	AI																			0
	4	Crossfall	AI																			0
	5	Crossing Points	AI														0.5					0.5
	6	Barrier Identification	AI														0.2					0.2
	7	Safety issues	AI														0.2					0.2
	8	Orientation signs	AI														0.5					0.5
W	9	Bus Stop Identification	E				1	1	1	1	1	1	1	1	1	1	1	1				1
A	10	Bus Stop layout	AI																			0
I	11	Safety issues	AI									0.5					0.2					0.5
T	12	Waiting environment	AI														0.2					0.2
	13	Waiting time	T						1	1	1		0.5		1				1			1
G	14	Gap Negotiation	AI																			0
E	15	Bus Service Identification	E		0.5		1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
T	16	Bus Type	AI						1	1	1	1	1	1	1	1					1	1
On	17	Cost	E						1	1	1	0.5	0.5							1		1
I	18	Gap Negotiation	AI																			0
N	19	Bus Stop layout	AI																			0

T	20	Path identification	E	1		1	1	1	1	0.5	1	1	1				0.5					1
E	21	Bus Service Identification	E				1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
R	22	Time wasted at interchange	T							0.5	1	0.5			1				1			1
Ch.	23	Safety issues	AI									0.5					0.2					0.5
R	24	Landmarks References	E	1		1	1	1	1	0.5	1	1	1		0.5							1
I	25	Direction	E	1		1	1	1	1	0.5	1	1	1	1	1	1		1	0.5			1
D	26	Distance (time or km)	T	1		1	1	1	1	0.5	1	1	1		0.5							1
E	27	Keep stability inside bus	AI																			0
G	28	Landmarks References	AI	1		1	1	1	1	0.5	1	1	1				0.5					1
E	29	Bus Stop Identification	E		0.5		1	1	1	1	1	1	1	1	1	1	1	1				1
T	30	Gap	AI																			0
Off	31	Bus Stop layout	AI																			0
W A L K D	32	Path identification	E	1	0.5	1	1	1	1	0.5	1	1	1				0.5					1
	33	Orientation signs	AI														0.5					0.5
	34	Distance to walk	T	1	0.5		1	1	1	0.5	1	1	1				0.5					1
	35	Footway Conditions	AI																			0
	36	Crossfall	AI																			0
	37	Crossing Points	AI														0.5					0.5
	38	Barrier Identification	AI														0.2					0.2
	39	Safety Issues	AI									0.5					0.2					0.5
	40	Target (Hospital) identification	E	1	1	1	1	1	1	0.5	1	1	1				0.5					1
				10.0	3.0	9.0	14.0	14.0	17.0	12.0	18.0	17.5	16.0	6.0	9.5	6.0	10.9	5.0	4.5	1.0	3.0	22.3

Table 4.9 - Total information by type in London

Type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
TOTAL	10.0	3.0	9.0	14.0	14.0	17.0	12.0	18.0	17.5	16.0	6.0	9.5	6.0	10.9	5.0	4.5	1.0	3.0
Total E	6.0	2.5	6.0	10.0	10.0	11.0	8.0	11.0	10.5	10.5	5.0	5.5	5.0	6.0	5.0	2.5	1.0	2.0
Total T	3.0	0.5	2.0	3.0	3.0	4.0	2.5	5.0	3.5	3.5	0.0	3.0	0.0	1.0	0.0	2.0	0.0	0.0
Total AI	1.0	0.0	1.0	1.0	1.0	2.0	1.5	2.0	3.5	2.0	1.0	1.0	1.0	3.9	0.0	0.0	0.0	1.0
%E	60.0%	83.3%	66.7%	71.4%	71.4%	64.7%	66.7%	61.1%	60.0%	65.6%	83.3%	57.9%	83.3%	4.0%	100.0%	55.6%	100.0%	66.7%
%T	30.0%	16.7%	22.2%	21.4%	21.4%	23.5%	20.8%	27.8%	20.0%	21.9%	0.0%	31.6%	0.0%	9.2%	0.0%	44.4%	0.0%	0.0%
%AI	10.0%	0.0%	11.1%	7.1%	7.1%	11.8%	12.5%	11.1%	20.0%	12.5%	16.7%	10.5%	16.7%	35.8%	0.0%	0.0%	0.0%	33.3%
INFOType	General					Operational												Current
TOTAL	50.0					126.4												176.4
Total E	34.5					83.0												117.5
Total T	11.5					24.5												36.0
Total AI	4.0					18.9												22.9
%E	69.0%					65.7%												66.6%
%T	23.0%					19.4%												20.4%
%AI	8.0%					15.0%												13.0%

The same sort of exercise was applied in the Brasília environment and it is presented in the next section.

4.3.1.2 Brasília Environment

Brasilia, the capital of Brazil, is a planned city constructed between 1956 and 1960. Planned for only 500,000 inhabitants, Brasilia has seen its population grow much more than expected. Several satellite cities have been created over the years to house the extra inhabitants. Brasilia's total population (including the satellite cities) is now 2,557,000 inhabitants (IBGE, 2008).

Although the city layout is easy to be understood and represented (See Figure of Plano Piloto B.1.b in Annex A1, Part B: Brasilia's Environment), displacements are very difficult for those who do not have private vehicles. The two main roadways in the core of the city, the various underpasses, the roundabouts and the vast amount of open spaces act as segregating barriers for people who desire or have to walk. Moreover, walking displacement is inhibited by the inaccessible conditions of footways, (when they exist). See sequence of figures in Table B1.1 - Plano Piloto and in Table B1.2 Satellite Cities - in Annex B.

Outside Plano Piloto, the region called RIDE (includes 22 satellites cities), the conditions are even worse due to disorganised occupation, absence of infrastructure and local planning. See figures see in Table B1.2, Annex B1.

The STDF (The Transport State Secretary) is responsible for the public transport police in Brasília. The current division between local public transport bodies are: TCB (Sociedade de Transportes Coletivos de Brasília Ltda – Bus Transport Society), DER (Departamento de Estradas de Rodagem- Highways Department), DFTRANS (Transporte Urbano do Distrito Federal – Urban Transport of Federal District of Brasilia) and METRO/DF (Companhia do Metropolitano do Distrito Federal – Underground System / Federal District). (<http://www.st.df.gov.br> / in 30/06/2010)

DMTU/DF (Departamento Metropolitano de Transportes Urbanos – Metropolitan Department of Urban Transport) was the former name of DFTRANS. In the old public society organization, part of the transport secretariat was extinguished and the new DFTRANS was created in 2003 through the need of modification on DMTU attributions.

DFTRANS is now responsible for bus line service planning (supply and demand), economic studies about performance evaluation and service cost, fare management, enforcement (management and control) of passenger quality services and administration and operations of terminal, stations and bus stops. Moreover, in theory, DFTRANS is responsible for the inclusion of disabled passengers.

Among the other bodies involved in the traffic are: DER, responsible for the rural and arterial roads and DETRAN (Departamento de Trânsito – Transit Department), responsible for urban roads. IPDF (Institute of Urban and Territorial Planning of DF) acts in conjunction with DER/DETRAN.

The fragmented structure and the lack of integrated policies among the different bodies of the transport system is obviously one of structural problems for the transport sector in Brasilia. The situation is even worse when the connection is necessary between the satellite cities where responsibilities are not well established due to physical boundaries restrictions and weaker political and administrative control.

The current public transport system (2009) is very inefficient: The network system is badly designed (there are lots of regions that are not served by the formal mainstream bus system) and the waiting time at bus stops can reach up to one hour in working-days (out of peak time), without any kind of supportive information (even telephone service is not able to answer the online situation of buses on route). The coordination between modes is fragile and the overcrowded condition during peak time is visible. To add it all fares are very high (around US\$ 1.68 for any round trip, which can represent 20 to 50% of the monthly salary).

Until 2007, pirate vans were allowed to operate and these tended to fail to respect minimum safety standards. The construction of Brasilia's metro system is going slowly because of a funding shortage. The operation time of the metro system is very limited during week days and even worse during weekends. Integration between bus and underground system is still very poor. As a consequence, a large number of people commute by private vehicle (commuting fleet: 964,534 or 76.5% of cars, DETRAN, 2007).

In terms of accessibility levels, Brasilia's bus system is characterised as an inaccessible system. Every single stage of a journey by bus in this city is inaccessible. In the walking stage, the footways, where they exist at all, are irregular and narrow. (See Figures B1.2, B1.3, B1.11 and B1.12). Bus stops platforms are inadequate for both the vehicle and pedestrians (Figures B1.3, B1.5, and B1.7). Many of the bus stop layouts are based on bays (the worst conditions for bus manoeuvring, Caiafa *et al.*, 2002). Additional to the bad design, the attitude of private car drivers is completely disrespectful, using bus stops as car parks, generating huge vertical and horizontal gaps between the bus and the kerb and creating safety problems for the bus passengers. (Figure B1.4).

In relation to the 'in-vehicle' stage, the bus fleet is old, noisy, badly maintained (constant broken vehicles during operation), dirty, uncomfortable, inaccessible, with steps and a turnstile at the fare collection point inside vehicle (Figure B1.5, B1.7 and B1.24). No type of visual/audible information system inside the bus is provided (the ticket collector and the driver are the main source of information). Drivers' driving behaviour is poor, and due to the need to follow a tight operational schedule, a complete absence of disability awareness is observed. Conditions of work inside vehicle are also unacceptable with high volume of noise and high temperatures. In the RIDE area, walking habits are almost impractical due to general lack of respect (population attitude: private buildings and private car's and truck drivers) and lack of local authority enhancement, among other factors. See figures in Table B1.2.

Only very recently, with the new Local Government from 2006, some gradual improvements have been implemented: more new (but still inaccessible) buses, the circulation of the private vans was forbidden and the operation of the underground system was extended. It is expected that there will be substantial improvements in public transport service with the new program 'Brasília Integrada', more details in Figure B1.1.

Although the new system (Brasília Integrada) represents an enormous advance in relation to the complete lack of transport policy suffered for more than 20 years, the system emphasises aspects of mobility (integration of Bus and Metro System via trunk-feeder corridor type and automatic ticket system), leaving accessibility issues for the future second plan. The proposal has been approved recently (January 2008), subject to the associated laws and regulations by Brasília's Parliament and negotiating with BID

(Banco Interamericano de Desenvolvimento) for financial resources (US\$ 270 millions: 177 BID and 93 GDF, portal GDF, <http://www.st.df.gov.br>, updated January 2008).

At present, the Bus Information System is almost non existent with just a free Telephone Service to provide information about the bus service and the best departure time that would cover a possible journey. Practical attempts to use it, during experiment, resulted in no answers and operators alleged that this service often does not work due to computer problems. Printed information is only available via the Internet and it consists of timetable, as illustrated in Figures B1.20 and B1.21. Route diagrams are not available for the public, although they do exist at the internal operational level within DFTRANS. No kind of information is found at Bus Stops. Table B1.5 illustrates the level of information provided at the principal bus station (Rodoviária Plano Piloto, the major centre of integration between Plano Piloto and the satellite cities): bus service number and 3-point-destination direction. The Orientation signage system is directed only to drivers. For example, there are no signs to indicate a pedestrian route to either the public or private hospital along the path to support pedestrians, Figure B1.25.

Table 4.10 illustrates the level of information provided by the current systems in Brasília. There are 7 different pieces of information covering general to operational information. The first three types are fully available in Newsagents, bookstores and via the internet. The remained are distributed by the Local Public Transport planners (GDF¹⁹+DFTRANS²⁰+operators). A few of them deliver aspects of accessibility. A route map is specifically provided by DFTRANS, but it is not directly available to public.

Table 4.10 - Information provided by Transport System in Brasilia

#	Title of Information Presented to Participant	Brief Description	Type	Status/ Provided by
1	Brasília City Map	Schematic representation of Brasília and satellites cities	General	Available
2	Hospital's Website	Multimedia presentation of hospital and its facilities	General	Available
3	Street Map	Schematic representation of streets	General	Available
4	Route Map from DFtrans	Orthogonal representation of the journey with cartographical type of map as background	Operational	DFTrans
5	Telephone Information System	Oral conversation which provides the service line for a particular pair O/D	Operational	GDF

¹⁹ GDF – Governo do Distrito Federal – Federal District Government

²⁰ DFTRANS - Transporte Urbano do Distrito Federal – Urban Transport of Federal District of Brasilia

6	Timetable	Origin and destination with schedule	Operational	GDF
7	Fare Costs	Price per journey type	Operational	GDF

Table 4.11 describes what each piece of information the Brasília's Bus Information

System covers in relation to the E, T, AI classification adopted in this study. As in the London case, the content of information provided by each information piece is classified as [1] if it fully covers the attribute in question or [0.5] if it partially covers the attribute in question and [blank] if it is not covered at all.

Table 4.11 - Information coverage by Bus System in Brasília

Stage	#	Content of Information	Type	1	2	3	4	5	6	7	max
Walk (O)	1	Path Identification Information	E	1		1					1
	2	Distance (time) to walk	T	1		1					1
	3	Footway Conditions	AI								0
	4	Crossfall	AI								0
	5	Crossing Points	AI								0
	6	Barrier Identification	AI								0
	7	Safety Issues	AI								0
	8	Orientation signs	AI								0
Wait	9	Bus Stop Identification	E					1	1		1
	10	Bus Stop layout	AI								0
	11	Safety issues	AI								0
	12	Waiting environment	AI								0
	13	Waiting time	T					1	1		1
Get On	14	Gap Negotiation	AI								0
	15	Bus Service Identification	E				1	1	1		1
	16	Bus Type	AI								0
	17	Cost	E					1		1	1
Interchange	18	Gap Negotiation	AI								0
	19	Bus Stop layout	AI								0
	20	Path identification	E				1				1
	21	Bus Service Identification	E				1	1	1		1
	22	Time wasted at interchange*	T					1	1		1
	23	Safety issues	AI								0
Ride	24	Landmarks References	E	1							1
	25	Direction	E	1				1			1
	26	Distance (time or km)	T	1			1	1			1
	27	Keep stability inside bus	AI								0
Get Off	28	Landmarks References	AI	1		1					1
	29	Bus Stop Identification	E						1		1
	30	Gap	AI								0
	31	Bus Stop layout	AI								0
Walk D	32	Path identification	E	1	1	1					1
	33	Orientation signs	AI								0
	34	Distance to walk	T	1		1					1
	35	Footway Conditions	AI								0
	36	Crossfall	AI								0
	37	Crossing Points	AI								0
	38	Barrier Identification	AI								0
	39	Safety Issues	AI								0
	40	Target (Hospital) Identification	E	1	1	1	4.0	8.0	6.0	1.0	17.0

The max-column registers the maximum value between all the 7 types of source of information for each subtask. The total coverage of the journey chain is: 17 (11 covering E-Type, 5 covering T-Type and 1 covering AI-Type or in %: 64.71%, 29.41% and 5.88%, respectively). Some subtasks (e.g.: bus service identification, path identification) are covered by different types of information, some are completely uncovered (e.g.: bus type, crossing points).

Table 4.12 illustrates the totals for each category E, T, AI provided by each piece of information. The percentage for each type of information in Brasília provided by the current bus system is: 63.9% for Essential information, 30.6% for information related to Time and only 5.9% for Accessibility Issues.

Table 4.12 - Total information by type in Brasilia

Type	1	2	3	4	5	6	7
TOTAL	9.0	2.0	6.0	4.0	8.0	6.0	1.0
Total E	5.0	2.0	3.0	3.0	5.0	4.0	1.0
Total T	3.0	0.0	2.0	1.0	3.0	2.0	0.0
Total AI	1.0	0.0	1.0	0.0	0.0	0.0	0.0
%E	55.6%	100.0%	50.0%	75.0%	62.5%	66.7%	100.0%
%T	33.3%	0.0%	33.3%	25.0%	37.5%	33.3%	0.0%
%AI	11.1%	0.0%	16.7%	0.0%	0.0%	0.0%	0.0%
INFOType	General			Operational		Current	
TOTAL	17.0			19.0		36.0	
Total E	10.0			13.0		23.0	
Total T	5.0			6.0		11.0	
Total AI	2.0			0.0		2.0	
%E	58.8%			68.4%		63.9%	
%T	29.4%			31.6%		30.6%	
%AI	11.8%			0.0%		5.6%	

4.3.1.3 Concluding Remarks

The major difference between the two environments is related to the amount of information provided by each system: in Brasilia's Case (7 pieces) there are less pieces of information available in shops/newspapers or provided by public transport planners than in London's Case (18 pieces). The other important difference is related to the access to the information provided by DFTrans or GDF which is difficult to be obtained (as explained in Chapter 8). Both the reduced content and the difficulty access of information constitute characteristics can be expected to impact on the process of planning and executing a journey in Brasília's Case, as is described in Chapters 7 and 8.

In terms of content, distribution of the three types of information (E, T, AI - without including any information created for the purpose of the present experiment) for each city is illustrated in Table 4.13.

It can be noticed that information related to accessibility issues represents the smallest part in both cases. Another point must also be made clear: Although the percentage of Essential type of information provided in both systems is roughly the same, 67% in London's and 64% Brasília's cases, deeper investigation of Tables 4.7 (London's case) and 4.10 (Brasília's case) shows that the number of information pieces and information data unit (refer to Section 4.3) is greater in London than in Brasília and the quality of information currently provided in London is far superior to the quality provided in Brasília. Information related to time is proportionally greater in Brasília (30.6%, 11) than in London (20.4%, 36) and Accessibility Issues type of information represents the neglected portion in both sites (2 in 36, for Brasília and 22,9 in 176,4 for London).

Table 4.13 – Difference between conceptual provision of E, T and AI type of information in London and in Brasília.

INFOType	London	Brasília
TOTAL	176.4	36.0
Total E	117.5	23.0
Total T	36.0	11.0
Total AI	22.9	2.0

Analysing the results obtained in the two environments it was perceived that there was a lack of supportive information delivering accessibility issues along the journey chain.

With the recommendations discussed in Chapter 3 (Section 3.4, towards the specifics of the study group – older people); the support of literature review on public transport users' requirement (Disability Discrimination Act – DDA (1995 and 2005); DETR (2001); DPTAC (2002); Burkhardt *et al.* (2002)); some interviews with disabled people conducted during Excalibur Project (Caiafa *et al.*, 2002a) and the standard-examples of international information systems collected during technical visits in different countries (United Kingdom, France, German, Spain, Brazil and Peru), a set of Accessibility Issues (AI-type) of information was created.

Table 4.14 includes a brief description of each piece of information specifically created for the experiment to be applied in the two city cases, keeping the same pattern as

possible. They are presented in Annex A2 – INFOChain Information. All the AI-type information was created using passive (printed) media. Symbols, text and pictures were the form used, according to the purpose of each information piece.

Table 4.14 – Accessibility Information type created for experiment

#	Title of Information Presented to Participant	Brief Description
1	Macro reference map	Direction of the journey on a big scale map focusing limits of boroughs and satellites cities
2	Radial Mobility	Cardinal disposition of bus stop and bus services direction
3	Picture sequence on site with directions	Sequence of pictures taken at the site on the walking stages
4	Drawing Sequence	Micro scales of streets and crossing point along the path to and from bus stops
5	Detailed description	Textual descriptions of the barriers found along the path to and from bus stops
6	Complete drawing map	Medium scales of the path to and from bus stops
7	Pictures and Information of bus stop area	Photo of bus stop layouts and information available at the site
8	Accessibility evaluation of bus stop platform	Textual description of accessibility conditions at bus stop site
9	Location of the nearest accessible bus stop	Nomination and distance of the nearest accessible bus stop
10	Pictures of Gaps examples	Picture of parked bus at bus stop sites
11	Picture of landmark sequence	Sequence of pictures taken at the site on the walking stages and on riding stage (Landmarks)
12	Route sketch with landmarks	Schematic route with landmarks along the riding stage
13	Detail description of riding	Textual description of itinerary.

The INFOChain pieces of information were created to help the user along the journey. The background approach was to take the benefit from the previous knowledge created by the available information provided by the public transport system and merge this with a new type of information tailored to reduce cognitive load (effort) and improve access along the journey. Three levels of supportive information were created:

- i. High-level (macro) geographical reference;
- ii. Learning level (improve bus system knowledge) ;
- iii. Specific (micro) level information.

High level of information helps the user to connect their previous knowledge with a broader area:

- i. Macro reference map: uses boroughs (cluster neighbourhoods) segmentation in London and a schematic map of Brasilia and satellites cities, to convey high-level of directions

Learning-type of information helps to extend knowledge about bus system.

- ii. Radial Mobility: uses compass direction to deliver the area the bus stop and the bus service serves.

Specific pieces were created where gaps were observed that might impact on the flow of information along each the journey.

Walking stages (Walking to the bus stop and from bus stop):

- iii. Picture sequences: sequence of pictures along the path to the bus stop illustrates the action-direction the users need to do, emphasizing different levels of hazard (crossing type, traffic directions, cycle lanes)
- iv. Drawing sequence: sequence of drawings (plan view) along the path to the bus stop illustrates the action-direction the users need to do, emphasizing different levels of hazard
- v. Textual Accessibility Assess: Textual descriptions of the barriers found along the path to and from bus stops
- vi. Complete drawing map (plan view) of the path from origin to the bus stop and from bus stop to destination with plotted places and traffic direction.

At Bus Stop:

- vii. Pictures and Information available at bus stop area.
- viii. Textual Accessibility Assess: Evaluation of bus stop platform with description of accessibility conditions at bus stop site.
- ix. Location of the nearest accessible bus stop: Nomination and distance of the nearest accessible bus stop (if the case).

Get On/Off Bus

- x. Pictures of Gaps examples: Picture of parked bus at bus stop sites.

Riding stage:

- xi. Textual Description of Riding: Textual description of itinerary with time and fare information.
- xii. Landmarks Pictures along the Riding: sequence of pictures of the main landmarks along the on bus journey captured from inside the bus.
- xiii. Schematic Route with Landmarks: schematic drawing of the route from origin to destination with landmarks picture and icons plotted along it.

Using the same subtasks classification for each stage of the journey chain (see Table 4.6) the new set of AI-type of information introduced (the 13 pieces) alters the initial provision of E, T and AI Type of information in each city, as illustrated by Table 4.16. Each piece was evaluated along the journey stages and a value between 0 and 1 was given to each attribute and they are presented in Table 4.15.

Table 4.15 – Accessibility Information type coverage

Stage	#	Content of Information	1	2	3	4	5	6	7	8	9	10	11	12	13	max
	1	Path identification Information			1	1	1	1								1
	2	Distance (time) to walk					1	1								1
	3	Footway Conditions			1		1									1
Walk (O)	4	Crossfall			0.5		1									1
	5	Crossing Points			1	1	1	1								1
	6	Barrier Identification			1	0.5	1									1
	7	Safety issues			0.5		1									1
	8	Orientation signs			1		1									1
	9	Bus Stop Identification		1					1	1	1	1				1
	10	Bus Stop layout							1	1	1	1				1
Wait	11	Safety issues							1	1						1
	12	Waiting environment							1	1						1
	13	Waiting time														0
	14	Gap Negotiation							1	1	1	1				1
Get On	15	Bus Service Identification		1											1	1
	16	Bus Type								1	1	1			1	1
	17	Cost													1	1
	18	Gap Negotiation							1							1
	19	Bus Stop layout							1							1
Interchange	20	Path identification			1	1	1									1
	21	Bus Service Identification		1											1	1
	22	Time wasted at interchange*														0
	23	Safety issues			0.5		1									1
	24	Landmarks References											1	1	1	1
Ride	25	Direction	1	1										1	1	1
	26	Distance (time or km)		0.5										0.5	1	1
	27	Keep stability inside bus											0.2		1	1

	28	Landmarks References									1		1		1	1
Get Off	29	Bus Stop Identification							1	1	1	1	1			1
	30	Gap							1	1	1	1				1
	31	Bus Stop layout							1	1	1	1	1			1
	32	Path identification			1	1	1	1								1
	33	Orientation signs			1		1									1
	34	Distance to walk			1		1	1								1
	35	Footway Conditions			1		1									1
Walk D	36	Crossfall			0.5		1									1
	37	Crossing Points			1	1	1	1								1
	38	Barrier Identification			1	0.5	1									1
	39	Safety Issues			0.5		1									1
	40	Target (Hospital) Identification			1	1	1	1								1
			1.0	4.5	15.5	7.0	19.0	7.0	10.0	9.0	8.0	7.0	4.2	2.5	9.0	38.0

Table 4.16 – Difference between conceptual provision of E, T and AI type of information in London and in Brasília, before and after new AI-type information.

Before Introduction of AI_type				After Introduction of AI_type			
INFOType	London	Brasília		INFOType	AI_Type	London	Brasília
TOTAL	176.4	36.0		TOTAL	103.7	280.1	139.7
Total E	117.5	23.0		Total E	37.0	154.5	60.0
Total T	36.0	11.0		Total T	7.0	43.0	18.0
Total AI	22.9	2.0		Total AI	59.7	82.6	61.7

Each set of information (available and produced), for each environment case, was presented to participants during experiments, described on Chapter 6. Chapters 7 and 8, the results, discuss the actual choices that each participant made to plan and to execute the journey in real environment.

4.4 CONCLUSIONS

This chapter has discussed some examples of Passenger Information Systems which emphasise the user's point of view. Specific information systems available in the two cities were analysed. In general terms, the first two layers of information – the general configuration of the city sites (schematic maps of the city) and the operational level (covered by timetables) - do not seem to have many differences in content. However, format and media do make a great difference - when looking from the user's perspective a simple format and media choices can establish the boundary of being accessible or not, the on-bus information provided by 'iBus' is a good example, if people with visual and audible impairments were the target public. Similarly, the simple knowledge about vehicle type (low floor) and bus platform type (adapted or not) for a wheelchair user can make a huge difference in individual's spectrum of choices.

Because accessibility issues are so related to specific features of the environments, neither of the cases encompasses all the necessary requirements to support the study of information throughout the journey, by older people in the real environmental conditions at the time the research was conducted. A taxonomy of information to be extracted along the journey chain was created to deliver consistency to the experimental procedures. The elements of the taxonomy constitute the independent variables (customised for each environment in study, London and Brasilia). In order to measure the relative effectiveness of the independent variables (its use (selection/process/use) from participant's point of view, under the INFOChain perspective) some metrics were established and they are explained in the next two chapters. Chapter 5 describes how users are going to be investigated and Chapter 6 describes the metrics used to assess the actual planning and execution of a journey by bus in an unfamiliar environment.

A set of accessibility type of information was created for the INFOChain experiment and applied (tested with volunteers) in both cities. The rationale of the INFOChain Information is to support the user and to reduce the stress of doing a journey to an unknown environment by providing accessibility issues type of information for each stage of the journey. The principle of the Journey Chain brought by Ackerman, Frye Tyler and Caiafa were incorporated and expanded to the concept of the "Information Chain".

5 INFOCHAIN EXPERIMENT METHODOLOGY – PART A: PARTICIPANTS (BATTERY TEST) & SETTINGS (ENVIRONMENT INVENTORY)

The different views about the interpretation of human cognitive systems and the general characteristics of human spatial knowledge were described in Chapter 3, concluding with some specifics about older people. As a result of this analysis a conceptual schema to explain the process of planning and undertaking a journey by bus (Figure 3.6) was proposed to support the proposed experiment. Chapter 4 presented an overview of information systems and the type of information available for the study environments. It also introduced the basic framework (task and subtasks for each stage of the journey chain) by which the individual's outputs could be analysed.

This chapter introduces the overview of the INFOChain methodology, created in this study, to investigate how individual use information. This consists of a brief description of the experiment tasks, the expected outputs and how the outputs are going to be analysed. Section 5.1 presents some preliminary considerations introducing the general idea of the experimental method. Section 5.2 presents the overall procedures of the experiment. Two pilot tests were conducted to test the initial experiment design and inform the full exercise. Their main conclusions are presented in Section 5.3.

This chapter also details the first part of the methodology (Part A): Battery Test and Environment Inventory, the initial organization of the inputs in order to apply SCA/CM (See Figure 1.1 for reference). The Battery Test (set of tests to capture individual provided capabilities) is described in Section 5.4 and its analysis in Section 5.5. Section 5.6 presents the analysis of the Environment Inventory, the features found in the environment (the capabilities required by the environment). The method to compare the outputs of the battery tests with the environment conditions is described in Sections 5.7. Finally Section 5.8 summarises the conclusions of this chapter.

The second part of the methodology details the application of SCA/CM and the procedures to extract individual use of information. This is presented in Chapter 6 (Methodology - Part B).

5.1 PRELIMINARY CONSIDERATIONS

As explained in the previous chapters, the nature of the phenomena studied in this research is centred on the individual. Users (in this case, older people) facing a problem-solving task (for example, a proposed journey to unfamiliar environment) are submitted to a set of stimuli (information provision – Information Chain) and are asked to make decisions (e.g. construct a plan using a cognitive process) that are dependent on their own characteristics (their individual provided capabilities) and react to face the real circumstances (the capabilities required by the environment) as they perceive them (via their cognitive processing) in order to achieve their final destination (target) and be able to do their desired activity (i.e. their motivation).

In order to study the phenomenon described the Capability Model was combined with the formal analysis SCA, using ABA format. Figure 5.1 and Figure 5.2 demonstrate the rationale used to build up the methodology: The SCA/CM extracts participants' strategies for planning and executing a journey by bus. The SCA principles formalise the systematic way to apply the tests (ABA format) to capture individual's mental process to plan the journey (A-natural strategy, B - treatment and A - strategy after treatment) and the CM principles formalise the interactions between the individual and the environment (how the individual processes information and uses information in a real situation).

To apply the SAC/CM it is necessary to understand the condition of the individual. Therefore the first phase of the INFOChain experiment is a Battery Test, which sets out to capture the participant's functions.

In general terms a battery test²¹ is a series of brief different tests used to assess the individual's potential for a specific knowledge domain. In the INFOChain context it consists of a set of tests to assess the individual's physical, sensory and cognitive functions related to the activity of planning and executing a journey by bus to an (un)familiar area. Together the tests indicate the Individual's Provided Capability. Details are presented in Section 5.4.

²¹ Battery Tests: set of tests commonly use in neuropsychology (e.g.: Minnesota Multiphasic Personality Inventory (Hathaway, S R and McKinley J C, 1940) and the Big Five personality factors (Goldberg,, 1993) and in ophthalmology (e.g.: Eye Examination Test).

It is also important to capture the settings where the experiment is conducted: the environment. This part is called the Environment Inventory. The Environment Inventory assesses features of the environment, which in the INFOChain case includes the physical characteristics (objective measures, e.g.: crossfall, width of footways, type of crossing) and the psychological characteristic (subjective measures, e.g.: sense of safety) of the areas where the journeys are executed. The available transport information in each city-case (e.g.: time-table, route-map) is also part of the environment. The AI information, which is specific to each particular city-case (explained in Chapter 4), is a separate component of the available transport information, and this is also tested in the experiment. Both types, the available city-based transport system information and the specific AI information, created for the experiment, correspond to the independent variable (that is manipulated during the application of SCA).

The Required Capabilities (the capabilities required by the environment, given by the physical and psychological features of the environment) is understood as the effort required to do the subtask. The effort is divided into five categories, from “high effort” to “very low effort”. Details are presented in Section 5.6.

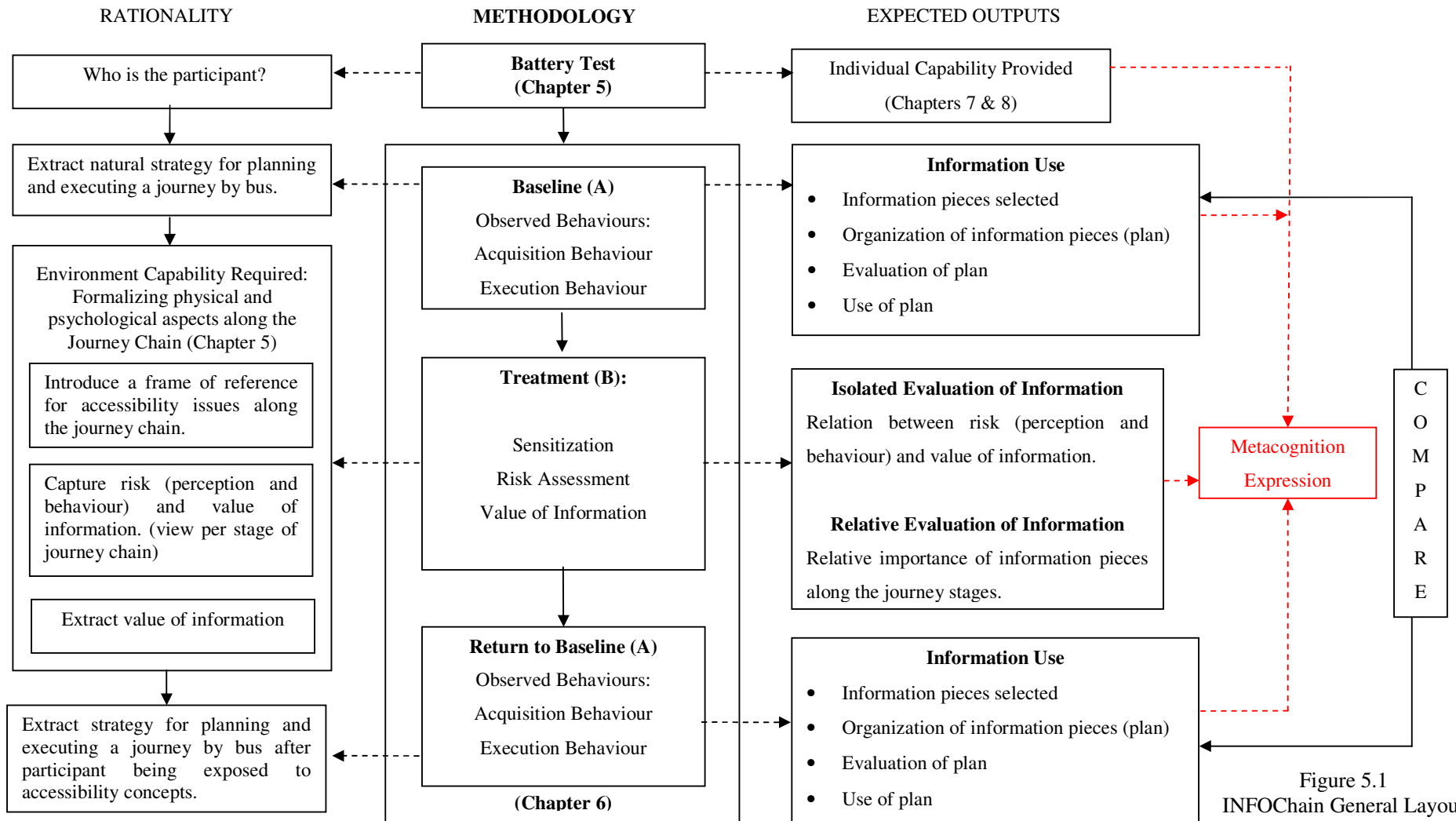


Figure 5.1
INFOChain General Layout

The second phase of the experiment explores how the individual uses of information (selection/process/use) in order to complete the activity. This phase follows SCA A-B-A format (Table 5.1). This allows:

A. Analysis of the original condition of information use (A phase):

The participant is asked to plan a journey to go to a hospital in a(n) (un)familiar area and then to execute the planned journey. The instrument of analysis is the participant's plan document, measured by: the number of each type of information (E, T, AI) selected to construct the plan.

The primary purpose of the A-phase measurement is to have a basis on which the subsequent efficacy of an experiment intervention can be evaluated. This phase is complemented by the application of the principles of the Capability Model, which captures how the information selected is processed before the journey and then used in the journey.

B. In the B-phase a treatment is introduced. In this case, the treatment consists of a formal presentation of the INFOChain schema and the introduction of the set of new AI_type of information for each stage of the journey. The set of information is presented and explained to the participant, who judges the importance of information and assesses the risk for each stage in two different (virtual) journeys by bus presented with the help of pictures, maps and other relevant information. These two bus journeys are called 'virtual journeys' (the participant does not execute the journey, just follows it as presented on paper, refer to Chapter 6, Section 6.2.2.2). The treatment phase ends with a game in which the participants are asked to 'buy' the information to plan a journey by bus, which functions as another form to assess the value of information. A time constraint is applied, based on the principles of Bounded Rationality (Jones, 2001), for this specific game. The element of analysis is the plan document.

C. In the second A-phase, which is a return to the baseline condition, the treatment is removed and the initial state of 'no knowledge' is reinstated. The participant is asked to plan the journey with a view to executing it later using all the information they choose from the available set (E, T, AI-types available from both the current system and information created for the experiment). The same types of observations were collected as in the first A-phase. A similar journey (to J1, explained in Chapter 7/8, Sections 7.1 (London) and 8.1 (Brasília)) was chosen using a different destination, keeping the characteristics as similar as possible to the original journey.

This phase seeks to check from the comparison with the initial baseline, for example, if there was an improvement in the selection of information to construct the plan, including the acceptance and the effective use of the new accessible information developed to reduce cognitive effort during the journey. This phase is also complemented by the application of the Capability Model principles, which captures how the information selected is processed before journey and used in journey.


The experiment procedure is presented in the subsequent sections. The general rationale of the experiment is presented first, followed by a general view of the experiment format. A brief section is dedicated to the pilot experiment which helped determine the final procedure. Sections 5.4 and 5.5 describe the components and the analysis of the Battery Test respectively and Section 5.6 describes the components and analysis of the Environment Inventory.

5.2 THE EXPERIMENT PROCEDURE

The experiment procedure to capture the participant's use of information is comprehensive. It includes different tasks (e.g.: oral, written, drawings, manipulation of objects), using different techniques (e.g.: open interviews, structured interviews and practical tasks) and different approaches (e.g.: 'top-down' approach by examining entire routes and 'bottom-up' approach considering actions that take place along a route) in different sets (real and virtual journeys) designed to assess the same constructs (e.g.: spatial knowledge, plan strategy, risks, affection, value of information, anxiety, attention) in relation to different stages (before and after journey) in order to understand how individuals make use of information (the plan) to guide their movement around an (un)familiar urban area (the journey).

As explained in Chapter 2, the mental representation of 'planning' cannot be observed directly and therefore the experiment has to incorporate the use of different techniques to identify how the process of planning a journey (use the information) takes place in participant's mind. Table 5.1 illustrates a general view of the experiment format. It shows the main steps which will be developed in the second part of the experiment.

Table 5.1 - Experiment General Assessment Formats

BACKGROUND	BASELINE (A)	TREATMENT (B)	BASELINE (A)
<p>There are two types of assessment on this phase:</p> <ol style="list-style-type: none"> 1. Battery Test: Assessment of individual functions: The participant is asked to do different tasks related to physical, sensorial and cognitive conditions to reveal individual's capability relevant to complete the task. 2. Environment Inventory: Assessment of the accessibility standard of the environment features to reveal the barriers of the journey. <p>Individual capability provided will be compared with environment capability required.</p>	<p>Real Journey Exercise (1st Journey)</p> <p>The participant is asked to plan and then do a journey with origin and destination given by the experimenter, in real environment. There are three different types of assessment to measure the quality of the plan, in this phase:</p> <ol style="list-style-type: none"> 1. Before Journey: Consists of a set of questions written and oral in order to identify how the participant plans the journey. 2. The Journey Execution A pair of origin destination is given to the participant who has to do the journey in real environment. 3. After Journey: Consists of a set of question to verify how the participant has done the journey. 	<p>Plan Sensitisation</p> <p>The participant is asked to plan and then judge a journey (origin/destination given), in virtual environment. There are two phases in this part of the experiment:</p> <ol style="list-style-type: none"> 1. Learning Phase: 2nd & 3rd Journeys Two virtual journeys are presented to the participant. Evaluation of information value and risk are requested for each stage along the journey chain. 2. Game Phase: 4th journey An amount of 'money' is given to the participant in order to buy the information to compose the plan. The participant balances personal needs with the total amount of money available to complete the task within a pre-fixed time. 	<p>Real Journey Exercise (5th Journey)</p> <p>The participant is asked to plan and then do a journey with origin and destination given by the experimenter, in real environment. There are three different types of assessment to measure the quality of the plan, in this phase:</p> <ol style="list-style-type: none"> 1. Before Journey: Consists of a set of questions written and oral in order to identify how the participant plans the journey. 2. The Journey Execution A pair of origin destination is given to the participant who has to do the journey in real environment. 3. After Journey: Consists of a set of question to verify how the participant has done the journey.
Experiment Outputs			
Deviation Curve along the Journey Chain	Real Journey (information use before treatment along the journey chain)	Participant's value of information and risks for each stage of the journey chain	Real Journey (information use after treatment along the journey chain)
1 st day	2 nd day	3 rd day	4 th day
History Effect 			

The history effect (Table 5.1) is defined as the effect of the participant's accumulated experience acquired during the experiment, or the possibility of developing strategies over the trial which obscure the underlying process, as stated by Zurif (1989). It is considered the main caveat of this research. The historical effect is one type of critique that some researchers have made against SCA (e.g. Zurif (1989), Bates *et al.* (1991) and Robertson *et al.* (1993)).

In the INFOChain perspective the history effect is expected to generate positive outputs in terms of the participant's subsequent selection of information: As a participant becomes more used to the set of information available, it is expected that they will make improvements to the quality of their plan, leading them to incorporate some accessibility-information types, as well as a reduction in the amount of time to complete the plan. The combined SCA/CM method was designed to explore the historical effect, by incorporating extensive tests to capture the possible alterations in a participant's knowledge and skills in the course of different phases of the experiment.

Figure 5.2 expands the initial view of the application of SCA/CM presented in Chapter 2 (Figure 2.3). The main steps of the INFOChain experiment were added, represented by dotted red boxes.

The individual component is decomposed into functions (physical, sensorial and cognitive), personal factor (affection/emotions) and general geographical data. The environment is decomposed in two main inventories (physical and subjective characteristics and information availability).

As explained in Chapter 2, The Capability Model explores the interaction between individual and environment. The theoretical output interaction between individual and environment, represented by the deviation curve, is presented in Section 5.8. The real interaction output between individual and environment is understood, in this study, as the coping strategies individual uses to deal with the real environment conditions and are presented in chapters 7 and 8.

The activity (visit a doctor/execute a journey by bus) is subject to some constraints: e.g. time, period of the day, cost, age. In the INFOChain experiment, time is the variable

which imposes psychological restriction to participants, in order to contextualise the experiment.

The activity, the set of tasks which, in theory, is an individual choice, which in the INFOChain experiment is reduced to what is available to be chosen in the environment (i.e.: the path and the bus service, not the hospital: the destination is fixed). In terms of information, the set of tasks (attributes) 'chosen' is a function of the personal awareness about the spectrum of the choices s(he) has: the information pieces. The achievement of an activity, according to the INFOChain restrictions, is discussed in Chapter 9.

The Capability Model provides the conceptual interaction between the awareness of individual capability and the awareness of the required environment capability, which in turn translates into how conceptually easy it is for this individual to complete the activity in the real environment and, consequently, how accessible a (bus) information system (of a city) is for this specific participant.

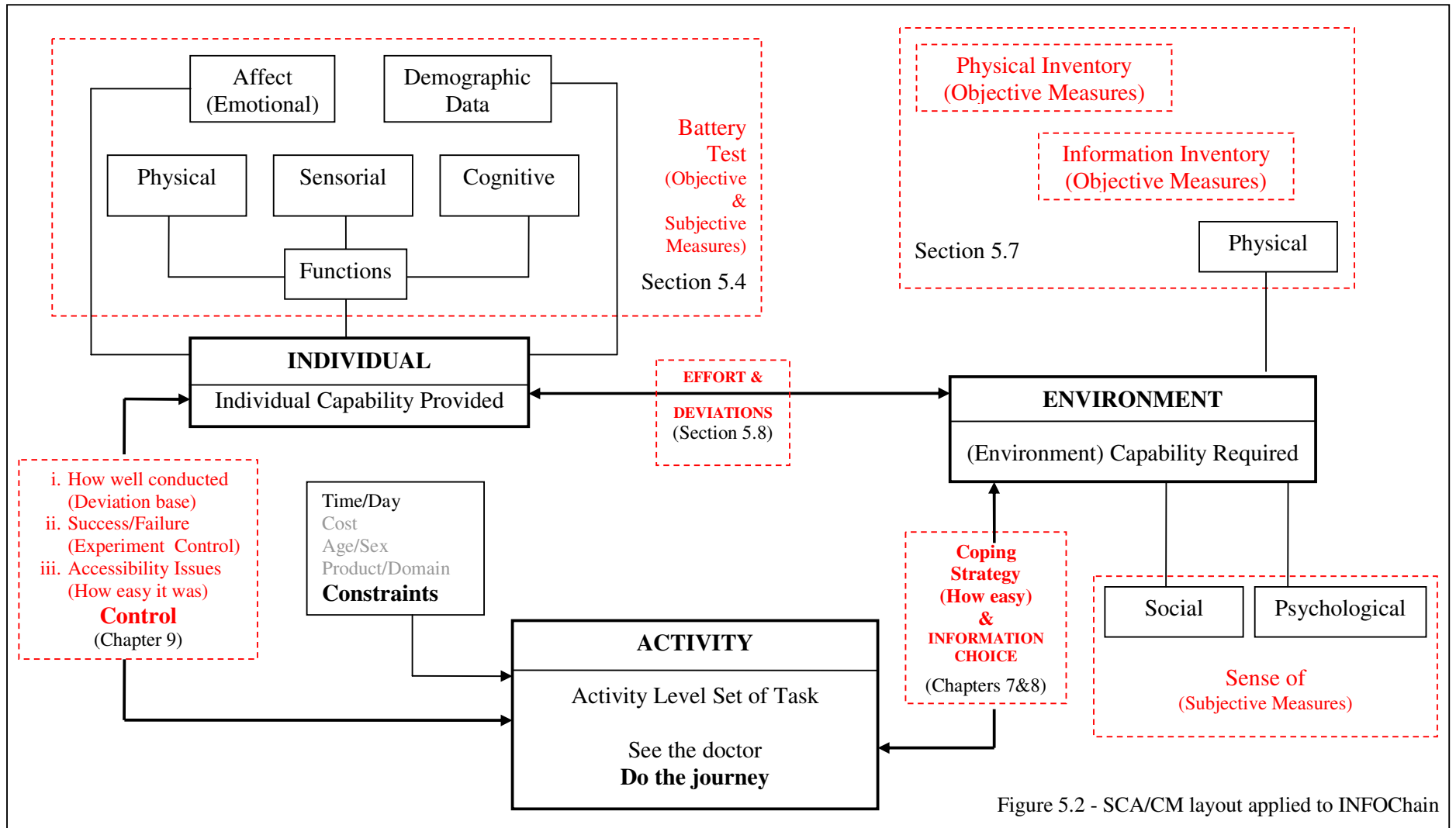


Figure 5.2 - SCA/CM layout applied to INFOChain

The proposed experiment is designed to tackle some questions related to information provision and the way information is used while planning. The individual measurements in the experiment consist of:

1. The Individual's (improvements in relation to the) use of information during the plan stage:
 - 1.1 If modifications to the planning pattern were demonstrated.
 - i. Differences of plan quality before and after treatment
 - ii. Memory impression (difficulties along the journey)
 - 1.2 Which kind of information was demanded and if specific information about accessibility issues was used when constructing the plan?
 - i. Consolidation of information before and after journey;
 - ii. Evolution of information selection;
 - iii. Comparison with values of information during treatment.

In order to answer particular questions about the use of Information Systems:

- A. Is it possible for this participant to plan the journey using the current level of information?
 - B. Is AI_type information attractive to this participant to a point that when familiarised with it s(he) would incorporate the new type in her/his pattern of planning a journey?
 - C. Is there a fundamental additional type of information that could be delivered to this participant in order to facilitate his/her journey (planning and moving phase)? Or
 - c.i) Is there a particular stage in the journey that is considered to be difficult? Which types of information could make it easier?
 - c.ii) Is there any piece of information (currently provided) that leads to bias or errors while planning the journey?
2. The Individual's behaviour during the execution of the journey:
 - 2.1. If the real journey has followed the plan.
 - i. Strategies used to cope with difficulties.
 - 2.2. If knowledge acquisition was demonstrated and incorporated in the representation of the journey.
 - i. Differences of representation of the journey before and after the journey.

- 2.3. Which kind of information was relevant after virtual evaluations of the journey?
- i. Consolidation of information before and after the journey;
 - ii. Evolution of information selection;
 - iii. Comparison with values of information during treatment.

In order to answer particular questions about the use of Information Systems in real environment

- D. Is the environment accessible for this participant? Or can the activity be completed with the current level of environment features?
- d.i) Is it possible for this participant to execute the journey with the current level of information?
 - d.ii) Is the participant's plan sufficient to cope with eventualities in the real world? Does it matter for him/her? Or in other words: Is this participant conscious of his/her limitation and would he/she construct a plan that takes his/her set of limitation into consideration?

Later the experiment outputs can be used to study differences between participants in order to answer more general questions:

- E. Has knowledge and the continuous provision of information about accessibility issues improved the participant's ability to execute a planning strategy?
- F. Is the environment condition (reflected in the information system) limiting the activity?

Analysis of the questions A to E is presented in Chapter 7 and 8 and question F is discussed in Chapter 9.

5.2.1 Validity and reliability of the experiment

In order to ensure the validity and reliability of the experiment some procedures were adopted. First, in Chapters 3 and 4 it has been noted that the literature shows that there are some differences in the way the concepts are understood and classified and even applied in different research perspectives (e.g.: psychologists, neuropsychologists, physiologists, ergonomists, geographers, architectures and computing-science). The main conclusion of that review is that in the area of information use, individual differences (different people) and their cultural aspects (different cities) are critical to the understanding of the problem. Moreover, because in this study individuals are

studied in real environment situations, interactions with the environment must also be comprehended.

“The individual differences approach takes into account the influence that different factors can have on the specific individual”, as stressed by Lewis (2003, apud Schinazi 2006, p: 3). Complementing Lewis, Schinazi (2006, p: 3) said that “this type of approach shifts the focus from the actual effect to the possible nature and causes of its presence. It is to detailed descriptions that the researcher should refer when trying to explain the presence of an effect”. He recommended (p:3) that “mutually and supportive techniques are necessary to account for the heterogeneity of experience and skills between participants and they are essential for the interpretation, application and generalization of results.” In order to respond to these comments, consistent and diversified tests were created and adapted to assess plan quality during all phases of the experiment.

The other aspect of the problem of this study concerns the environment and the presence or absence of some elements that, according to some researchers (Haken and Portugali, 2003), transmit more information than others and are, therefore, more significant in making the city legible, (and, in the study case, accessible). The counterpart is the individual limitation of short-term memory (Miller, 1956) and the several ‘tricks’ people use to overcome this innate limitation (e.g.: increase the dimensionality of the data, re-arrange it into groups, ‘chunks’ or a hierarchical structure, or in a sequential order). As set out by Portugali (2002, apud Haken and Portugali 2003, p: 400), “people do not passively perceive and memorize the entire information offered but rather they actively ‘select’ the elements that convey the highest value of information”. Portugali described this as ‘actively landmarking’, ‘edging’ elements in the environment as they enter one’s ‘window’. In this way people “cognitively and actively give meaning to the city and the many elements of which it is composed.” (p: 403)

To extract this process, a combination of quantitative and qualitative scores was then chosen to measure the constructs involved in the problem. This was felt as a necessity to improve not only the ‘construct validity’ of the conceptual INFOChain schema (Figure 3.6 – Cognitive Process along a Journey) but also to check the ‘ecological validity’ of the Battery Test (the actual competence to predict a person’s performance in a real environment) and the ‘criterion validity’ of the Capability Model (e.g. anticipate

hazards in the environment that might affect the participant's use of information while planning and executing a journey). The experiment is designed to allow the researcher to understand better what a person can do under real environment conditions.

As a consequence of the recommendations in the literature it was decided to extract information from individuals using a structured approach in an open interview, in which the conversation is highly controlled by the interviewer. The questions are standardised with a mix of open closed questions. This strategy ensures that all the interviewees are asked the same questions, in the same order. This choice provides not only comparability of responses (within participant and between participants) but also allows flexibility to engage in a more relaxing conversation exploring feelings, problems and coping strategies if interesting responses (circumstances) arise. The structured questions were then mixed with standard cognitive tests (e.g.: immediate word recall, picture recognition, numeric working memory, audible working memory and spatial working memory) and tailored tests created for the experiment (e.g. spatial instruction test, journey problem solving test). This approach was used to compose the Battery test set (explained in Section 5.4) and the observations during the baseline and treatment, explained in Chapter 6.

To collect information from the real environment, simple site inventory tours were executed during the same period (off peak) when the real experiments would be conducted. The main aspects of each environment were photographed and measured (e.g.: crossing type, bus stop layout, inclination of footways) and are explained in Section 5.6. For the journey execution analysis, detailed in Chapter 6, specific tests (e.g.: route memory, landmark location, distance and time estimation) were constructed and arranged in a formal but flexible format using SCA principles.

The whole experiment procedure (see Table 5.1) was tested by two pilot experiments.

5.3 PILOT EXPERIMENT OUTPUTS

As anticipated in chapter 2 (Section 2.1), two pilot experiments were carried out because some of the measures were new and were created for the experiment proposed in this study. It was also important to check the viability of the approach – e.g. the time

it would take – and the need for equipment, space etc to be available. The original experiment format involved sequential activities and its suitability needed to be tested in advance. The pilots involved the battery set tests, the procedures for real journey plans/execution and the procedures for virtual journey evaluation. The main goals of the pilot experiment were:

- i. To check the proposed tasks and subtasks involved in each stage of the journey;
- ii. To test the functioning of equipment, in the case of physical assessment;
- iii. To familiarize the researcher with the standard protocols for testing visual and audible functions, as well as the standard tests for memory levels;
- iv. To test the participant's reaction and cooperation;
- v. To test the impact of the presence of the observer on participant performance;
- vi. To test the usefulness of the cognitive variables;
- vii. To establish the duration required for each of the measurements, to estimate the time needed for the whole experiment;
- viii. To have an idea of the mental load process for the participant: the degree of difficulty (execution and understanding) of each part of the experiment;
- ix. To assess the sequential effects of the whole experiment;
- x. To evaluate the applicability of the data for the purpose of the study.

The outputs were used to improve the quality of the tests, to test the real journeys exercise and to refine the protocols applied in the real experiment. On average the whole experiment lasted 6 hours and was completed in 3 days. All the tasks could be understood and executed by participants after adjustments resulting from the post experiment report. However one point might be underlined: the pilot tests showed that it would clearly be necessary to have a commitment between the participant and the researcher in order to complete the experiment. The participant needs to be informed about the duration of the experiment and the importance of completing the whole exercise (although it must be stressed that he/she can leave the experiment if they desire). For the real experiment a four day format was adopted (See figure 5.1).

The next section explains how the individual capabilities are captured and how the outputs are compared to the real environment conditions of the journey.

5.4 THE BATTERY TEST

Battery tests are defined as a series of brief different tests applied to assess the individual's potential for a specific knowledge domain. In a broader context, it is used to define who may pursue training or as an admission criteria for a specific purpose or to detect impairment of human cognitive performance. In general, the tests do not attempt to judge a person's capacity (limitations) but rather they determine qualification for something or their ability (capability) in a specific area of knowledge.

In the INFOChain context the battery consists of a set of tests to capture basic individual capabilities related to the activity in the proposed study (execute a journey by bus in an unfamiliar environment). The tests assess major aspects of physical function, sensory functions (vision and hearing) and cognitive functions (working memory, attention and affection).

Figure 5.2 illustrates the main components of the battery tests. The standard battery of tests in INFOChain includes:

1. Personal Data (sex, age, level of education, medical condition, and experience in public transport use).
2. Personal Features components reveal the participant's subjective opinion about bus systems and they are considered to be important in the understanding of individual problem-solving process construction. They are represented by affection, risk and preferences.
 - i. Affection: impression about service quality; Affection is a form of emotion defined as positive (like) or negative (dislike) evaluative feelings towards an external stimulus (Slovic, p: 13). In this study it is considered that affection can influence the ability to anticipate, to plan accordingly within a complex social environment, and make choices. These abilities are necessary for reasoning to culminate in decision making (Damasio, 1994).
 - ii. Risk perception and behaviour towards the bus system; Risk is a concept that is closely related to affection. Peters and Slovic (1996) suggested that affect functions as orienting dispositions, helping people assessing risk (risk perception) and responding to risk (risk behaviour).
 - iii. Preferences: An Encoded Form can provide useful information for the second part of the experiment, when interpretation, value and selection of information are captured.

3. Physical and Sensory Functions: Standard tests to measure sensory (vision and hearing) and physical limitations (body part movements)
4. Cognitive Functions: Imaginative function; memory function, body axes awareness, language preferences, visual spatial abilities (direction and orientation), topographic knowledge and specific public transport knowledge.

Individual tests can be added to or removed from the battery to target specific cognitive domains. The topics were established according to the literature (see Chapters 2 and 3), reflecting the important points about cognitive knowledge and spatial apprehension as summarised in the INFOChain Conceptual Schema (Figure 3.6). The functional and sensory tests were adopted or developed taking into consideration the actions needed to execute a journey by bus (e.g.: move head, read a sign, listen to an instruction, recognise a landmark).

The range of the parameters in Figure 5.3 reflects the recommendations of the WHO (World Health Organization, (2002)). The outputs of the main components of the individual's capabilities are described in terms of a range of impairments in the case of physical and sensory components and by a competence range (where 'competence' is regarded as what can be achieved without assistance) in the case of the cognitive component. The actual value of any impairment is quantified and compared using medical clinical research, in the case of visual and hearing tests. The functions of body movement were quantified using ergonomic tables. The values of competence are compared with the standards of psychological tests and recommendations found in the literature, in the case of cognitive functions. Table 5.2 summarises the descriptions and objectives of the tests applied in the battery phase.

The construction of the Battery Tests was based on the extensive literature review (Chapter 2 and Chapter 3) done before the application of the procedures to understand the participant's use of information (select/process/use). With the results obtained after the application of the INFOChain experiment in the two city-cases (Chapter 7, 8 and 9) it is possible to recommend a shorter version of the Battery Test. The most significant tests to understand individual use of information are highlighted (in bold) in Table 5.2. The Language Preference (#5) is considered to be important when the emphasis is in the format of information (symbolic, textual, map). The general demographic data can also

be reduced to age, sex, education level, frequency of public transport use and the reported clinical conditions: impairment, disease and assistance device.

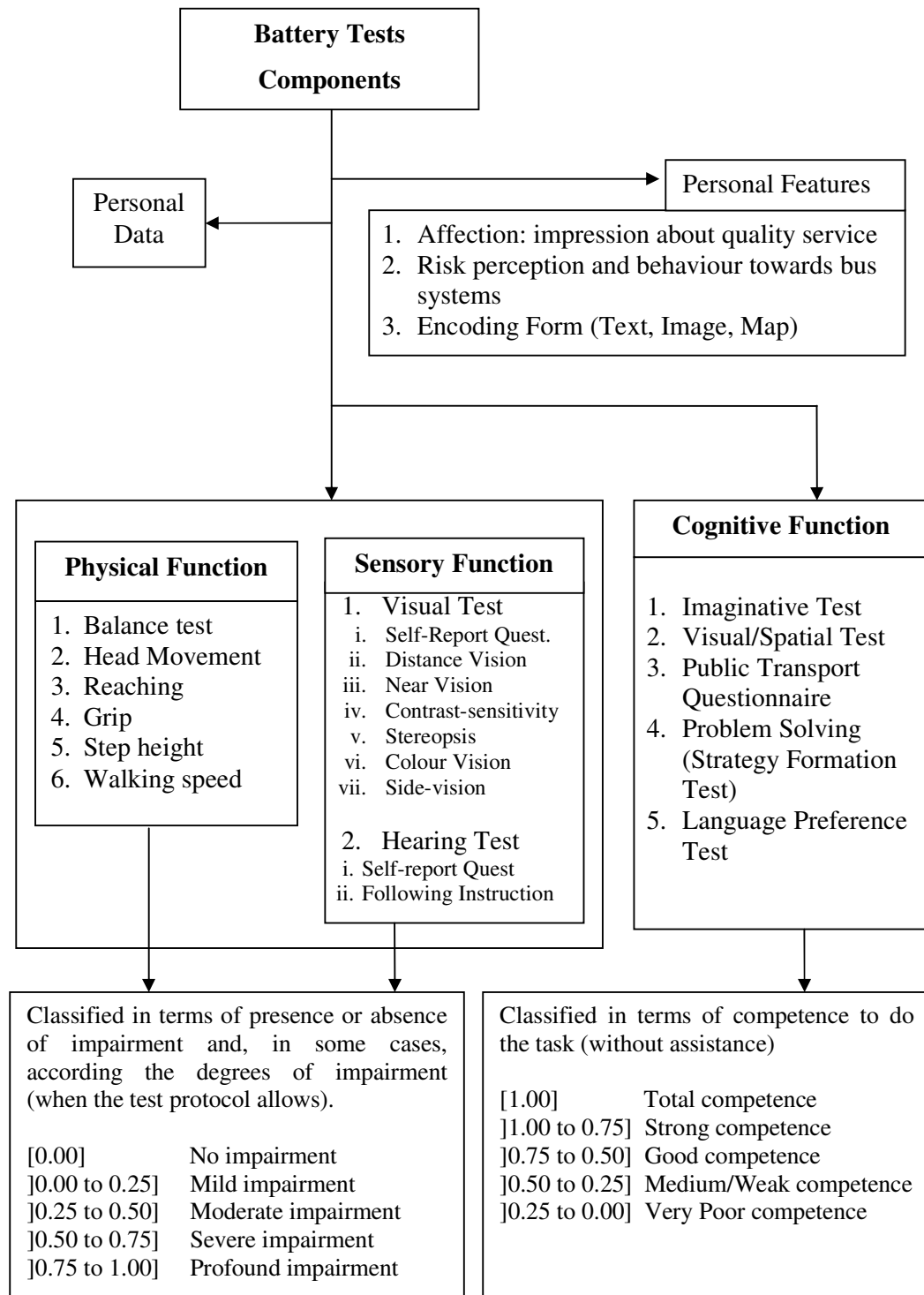


Figure 5.3 - Individual Capability Provision

Table 5.2 – Battery Test Brief Description

Section	Component	Description (# Test. Title)	Objective	Background Sources
5.4.1	Personal Knowledge/ Experience	1. Individual Personal Test Type: Multiple choice quick questionnaire	Acquire personal data (e.g.,: age, education, experience)	General Demographic Data
5.4.2	Physical and Sensory Functions	2. Functional Limitations Type: Practical test	Check functional limitations (e.g.: near/long distance vision, instructions comprehension)	Steenbekkers and Beijsterveldt (1998), Carlsson (2002), Massof and Rubin (2001), Rubin <i>et al.</i> (2001) and RNID
5.4.3	Cognitive Function: Memory	3. Memory Tests (STM and LTM) Type: Practical tests	Check memory limitations: visual and audible short memory; spatial memory and recognition for long term memory	Miller (1956). Atkinson & Shiffrin, (1968), Waugh & Norman (1965) Vance & Singer (1979), Presson (1989), Gathercole & Adams (1993) and Jaquith (1996).
5.4.4	Cognitive Function: Imaginative capacity	4. Imaginative Test Type: Likert Scale and objective question	Check subjective and objective imaginary capacity	Likert (1932), Sternberg (1983) and Huska- Chirroussel (2000), examples of Year 7 exam tests, specified in Table5.8.
5.4.5	Personal Feature: Encoding Form	5. Language Preference Type: Multiple choice quick questionnaire	Test language preferences (textual, schematic or graphic)	Huska-Chirroussel (2000)
5.4.6	Cognitive Function: Body axes awareness	6. Picture Task – Road Map Test of Direction Sense Type: Decide L/R on a city map (9 blocks)	Check ability to maintain personal and extra personal orientation	Huska-Chirroussel (2000)

5.4.7	Cognitive Function: Visual Spatial Abilities	7. Orientation Test Type: Drawing in perspective	Check spatial apprehension and body axes	Bryant, Tversky and Franklin (1992) and Bryant (1999)
5.4.8	Cognitive Function: Topographic Knowledge/Memory	8. Place Cognition (City Knowledge Test) Type: Plot landmark in Euclidean System	Check spatial dominance of the city. Plot landmarks on a Euclidean reference space.	Created for INFOChain
5.4.9	Cognitive Function: Knowledge about Transport System Personal Feature: Affection (quality of service)	9. User's objective knowledge and subjective opinion about Public Transport System Type: Discursive questionnaire	Check user's view/feelings about bus systems. Verify the rejection in relation to bus system. Test affection (positive/negative expression)	Rhode (1957) and Damasio (1994)
5.4.10	Cognitive Function: Problem Solving - Strategic Formation	10. Introspective reports about a journey Type: open written question	Check the problem solving process of doing a journey. Extract the first theoretical strategy to do a journey without being contaminated with experiment procedures.	Created for INFOChain
5.4.11	Personal Feature: Risk Perception and Behaviour	11. Risk Perception and Risk Behaviour Type: Rating Scale	Check individual risk perception and behaviours along different stages of the journey.	Weber (2002), Sitkin and Weingart (1995), Lopes (1987) March and Saphira (1992), Ajzen and Fishbeins (1977, 2000), Peter and Slovic (1996) Oxley (2000), Ritter <i>et al.</i> (2000), Oxley and Gallon (1995), DETR (1999), DETR (2001) and Caiafa (2004).
5.4.12	Post Interview	12. Post Interview Type: Open question and a rating option	Evaluate the level of understanding of the exercise	Aroson (1990) and Christesnsen (1994)

The battery test is applied to each participant on the first day of their experiment as the first activity developed by the individual. No time restriction is imposed but the time for each test is recorded. A final report is generated about the individual's profile indicating his/her capabilities. The results of the tests were only analysed at the end of the fourth day, in order to minimise the potential risk of bias that such knowledge could introduce into the interpretation of the journey phase analysis. If it emerges during the tests that a participant is unable to complete the journey without additional assistance, their data are removed from the analysis.

The tests are described in subsequent Tables 5.3 to 5.14 and Figures 5.3 to 5.8, where they are reproduced in the same format as they were given to participant.

5.4.1 Test 1 - Individual Personal Test

Fifteen questions identify the social variables that can influence a participant's behaviour in the transport field, among them: age, level of education, social status. They also investigate participant's experience in using public transport.

Table 5.3 – Battery Test: Personal Data

1. Age:																							
2. Sex:																							
3. Nationality:																							
4. Mother tongue:																							
5. Profession	<input type="checkbox"/> Employed <input type="checkbox"/> Unemployed <input type="checkbox"/> Retired																						
6. Education (highest level)	<input type="checkbox"/> Have not finished Secondary School. <input type="checkbox"/> College <input type="checkbox"/> Graduated <input type="checkbox"/> Post-graduated																						
7. Postcode or Borough where you live, please specify →	Please specify.																						
8. Do you have any kind of impairment that can create difficult when you going out? <input type="checkbox"/> No. <input type="checkbox"/> Yes, please specify →	<input type="checkbox"/> memory disorder <input type="checkbox"/> visual impairment <input type="checkbox"/> hearing impairment <input type="checkbox"/> impairment in superior members <input type="checkbox"/> impairment in inferior members <input type="checkbox"/> labyrinthine How long: _____																						
9. Do you use any assistive device such as glasses, hearing aid, wheelchair?	<input type="checkbox"/> No <input type="checkbox"/> Yes, please specify _____ _____																						
10. Medical Diagnosis of existing Main Health Conditions	<input type="checkbox"/> No medical conditions exists <input type="checkbox"/> _____ <input type="checkbox"/> _____ <input type="checkbox"/> _____ <input type="checkbox"/> _____																						
11. Computer Knowledge: Evaluate yourself.	<table border="1"> <tr> <td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> <tr> <td colspan="5">No</td> <td colspan="6">Expert</td> </tr> </table> Knowledge	0	1	2	3	4	5	6	7	8	9	10	No					Expert					
0	1	2	3	4	5	6	7	8	9	10													
No					Expert																		

12. Internet Use: Evaluate yourself.	<table border="1"> <tr> <td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> </table> No Knowledge Expert	0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10		
13. Live in London since ...	19_ _											
14. Have you the habit to walk around the city?												
15. Do you have a private car? Can you drive your private car?	If yes, please estimates (Km or miles/year): License drive since 19 --											
16. Do you usually drive in London?												
17. Experience using Public Transport (not only in London)	since 19_ _											
18. Frequency of use Public Transport	<input type="checkbox"/> up to twice a week <input type="checkbox"/> 3 to 5 times a week <input type="checkbox"/> once a month											
19. In your present state of health, how much difficulty do you have walking long distances (1 Km) without assistance? (Nominal Performance)	<input type="checkbox"/> No difficulty <input type="checkbox"/> Mild difficulty <input type="checkbox"/> Moderate difficulty <input type="checkbox"/> Severe difficulty <input type="checkbox"/> Complete difficulty											
20. In your present state of health, how much difficulty do you have using buses without assistance? (Nominal Performance)	<input type="checkbox"/> No difficulty <input type="checkbox"/> Mild difficulty <input type="checkbox"/> Moderate difficulty <input type="checkbox"/> Severe difficulty <input type="checkbox"/> Complete difficulty											

5.4.2 Tests 2 – Functional Limitations

5.4.2.1 Test 2.1 - Functional Tests: The Sensory Capacity Tests

This test aims to capture the participant's impairments that might affect the execution of a journey by bus. It is a quick test and is neither intended to develop a medical nor a physiological approach toward the participant. The spectrum of activities included in the test was based on the study about aspects of personal components of accessibility developed by Steenbekkers and Beijsterveldt (1998) and Carlsson (2002).

Table 5.4 summarises the type of tests applied in this phase. The Sensory Capacity tests are divided into two parts. The first part consists of a questionnaire for which the participant writes down the answers and functions as a self-report questionnaire. The second part consists of some practical tests simulating basic activities in the real environment. The third part is the practical side of the test using standard tests to measure vision. At the time of the experiment tests the equipment to test hearing levels audiometer failed and the individual hearing level (audiogram) could not be captured. The 'Following Instruction Tests' (Table 5.4) was used to assess hearing capability.

Table 5.4 – Battery Tests: Sensory Tests

Sense	Type	Question/Task/Test	Alternatives
Visual Condition	Self-Report Assessment	1. How would you describe your eyesight?	<input type="checkbox"/> I have good vision <input type="checkbox"/> I have a general good vision with my glasses <input type="checkbox"/> Even with glasses I have difficulties <input type="checkbox"/> I have great difficulty seeing
		2. Use of spectacles? (Y/N)	Description of optician diagnoses
		3. Impaired Colour Vision?	<input type="checkbox"/> Yes <input type="checkbox"/> No
		4. Contrast Sensitive?	
		5. Light Sensitive?	
		6. Sensitivity to motion?	
		7. Depth related difficulties?	
		8. Side vision difficulties?	
	Practical Test	1. Read a map (A to Z)	<input type="checkbox"/> Use of <input type="checkbox"/> No problem <input type="checkbox"/> with <input type="checkbox"/> Not able Spectacles difficulties
		2. Read Timetable (at bus stop)	
		3. Read Bus Sign (at bus stop)	
		4. Identify the number of the bus at bus stop	
		5. Identify street name from inside the bus	
		6. Read Route inside the bus	
		7. Read Bus Sign from inside the bus	
		8. Identify name of street	
	Clinical Vision Test	1. Distance Vision Acuity	LogMar Cabinet
		2. Near Vision Acuity	LogMar Chart
		3. Contrast Sensitivity Test	Pelli-Robson Chart
		4. Stereotest	Frisby test
		5. Colour Vision Test	Farnsworth D15
		6. Peripheral Vision Test	Protactor Device
Hearing Condition	Self-Report Assessment	1. How would you describe your hearing, without the use of a hearing aid(s) or a cochlear implant?	<input type="checkbox"/> I have no noticeable loss <input type="checkbox"/> I have some difficulty hearing what is being said, mainly in noisy situations <input type="checkbox"/> I have some difficulty hearing what is being said, even in quiet situations <input type="checkbox"/> I cannot hear what is being said, but I can hear some sounds <input type="checkbox"/> I am profoundly deaf
		2. Do you normally use a hearing aid or cochlear implant?	<input type="checkbox"/> Hearing aid in one ear <input type="checkbox"/> Hearing aids in both ears <input type="checkbox"/> Have hearing aids but rarely use them <input type="checkbox"/> Cochlear implant <input type="checkbox"/> Neither hearing aid(s) nor cochlear implant
		3. How would you describe your hearing, when you use a hearing aid(s) or a cochlear implant?	<input type="checkbox"/> I have no noticeable loss <input type="checkbox"/> I have some difficulty hearing what is being said, mainly in noisy situations <input type="checkbox"/> I have some difficulty hearing what is being said, even in quiet situations <input type="checkbox"/> I cannot hear what is being said, but I can hear some sounds <input type="checkbox"/> I am profoundly deaf
		4. Type of Hearing Aid	<input type="checkbox"/> Behind-the-ear (BTE) hearing aids

Hearing Condition	Cont. Self-Report Assessment		<input type="checkbox"/> In-the-ear (ITE) hearing aids <input type="checkbox"/> Body-worn hearing aids <input type="checkbox"/> Bone conduction hearing aids <input type="checkbox"/> CROS/BiCROS hearing aids <input type="checkbox"/> Disposable hearing aids
		5. Does your hearing aid(s) have a T setting? (This is used to pick up sounds from an induction loop or telephone)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know
		6. Which of the following methods of communication do you use?	<input type="checkbox"/> British Sign Language <input type="checkbox"/> Sign Supported English <input type="checkbox"/> Speaking <input type="checkbox"/> Lip-reading <input type="checkbox"/> Writing <input type="checkbox"/> Finger spelling <input type="checkbox"/> Other
		7. Is this communication different during a journey by bus?	
		8. How would you describe your impairment?	
		9. Do you miss any of the following when you are out? Announcements in bus/railway stations Announcements in a bus, train or plane Approaching traffic Approaching emergency vehicles Other people approaching Announcements in waiting rooms	
		10. Can you communicate with the driver inside the bus?	<input type="checkbox"/> Never <input type="checkbox"/> Occasionally <input type="checkbox"/> Frequently <input type="checkbox"/> Often
		11. Have you have difficulties in demand/understanding navigation orientation from people on street?	
		12. How often do you use an induction loop in the following situations?	
		Ticket Office	
		Inside Bus	
		Practical test: Following Instruction Tests	13. Hearing Practical test (7 instruction memorised)	7 instructions are read to participant while he/she draw them on a city map diagram, immediately after the last sentence.

The self-report questionnaire for hearing was based on the RNID recommendations extracted from the RNID website (www.rnid.org.uk, accessed on March/2005)

The selection of the visual tests was based on studies that describe how visual impairment affects mobility, see Massof and Rubin (2001), Rubin (2001).

Table 5.5 – Brief Description of Ophthalmology Battery Test

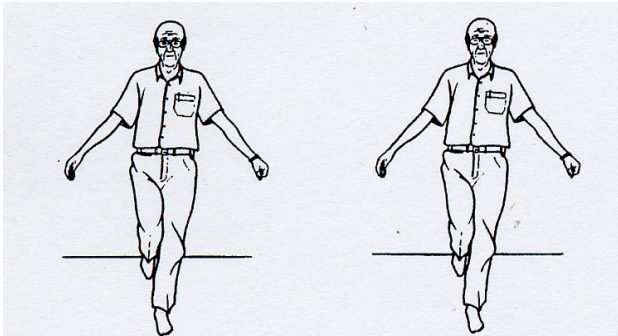
Test Name	Test protocol and scoring
1. Distance Vision Acuity (LogMar Cabinet)	Scoring: when scoring on a line-by-line basis, a line is considered read if more than half of the letters are identified correct.
2. Near Vision Acuity (LogMar Chart)	Scoring: when scoring on a line-by-line basis, a line is considered read if more than half of the words are identified correct.
3. Contrast Sensitivity Test Pelli-Robson Charts	Scoring: The participant is assigned a score based on the contrast of the last group in which two or three letters were correctly read. A score of 2 means that

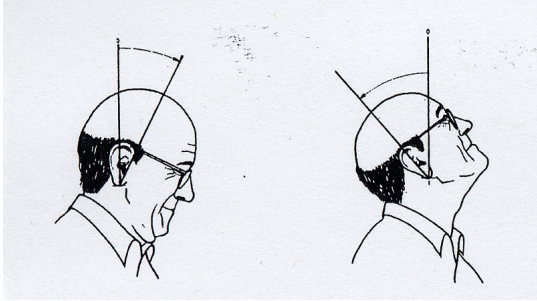
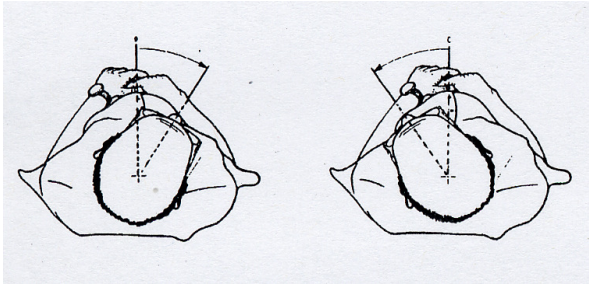
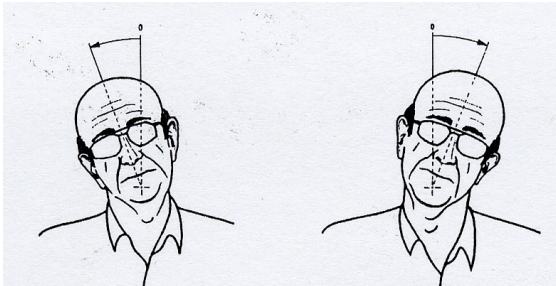
Continuing Contrast Sensitivity Test Pelli-Robson Charts	the subject was able to read at least two of the three letters with a contrast of 1 percent (contrast sensitivity = 100 percent or log 2). A Pelli-Robson score of 2.0 indicates normal contrast sensitivity of 100 percent. Scores less than 2.0 signify poorer contrast sensitivity. Pelli-Robson contrast sensitivity score of less than 1.5 is consistent with visual impairment and a score of less than 1.0 represents in visual disability.
4. Stereotest (Frisby test)	Scoring: Record “Stereopsis Present” if reliable discrimination is established. If the participant reports being able to see a circle-in-depth even when it is pointed out, record Stereopsis Not Demonstrated
5. Colour Vision Test	Scoring: Participant is considered without impairment if the sequence obtained is linear. Otherwise the pattern is identified and classified accordingly: protan, deutan and tritan defects (missing colour receptors: red, green, blue)
6. Side Vision Test	Scoring: Each stimulus is recorded three times and the angle of detection corresponds to the average of the measures. A table is being constructed in order to classify the performance of the participant.

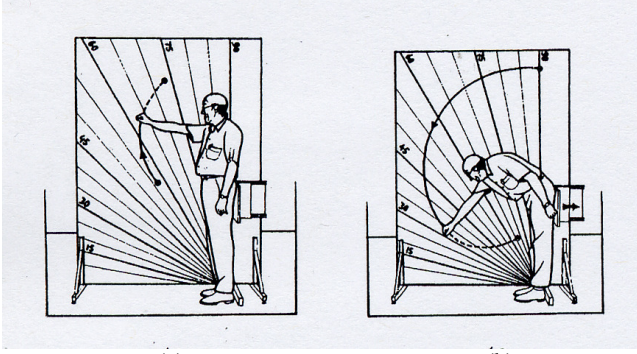
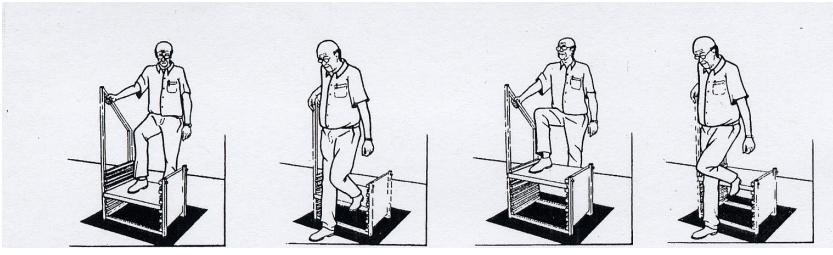
5.4.2.2 Test 2.2 - Functional tests: Body Function Test

Table 5.6 illustrates the tests used to check the body movements necessary to use public transport. They are extracted from an ergonomic study developed by Steenbekkers and Beijsterveldt (Design-relevant characteristics of ageing users, 1998).

Table 5.6 – Battery Test: Function Tests (Steenbekkers and Beijsterveldt, 1998)

Balance	<p>Time (seconds) that a person can remain standing on one preferred leg with their</p> 
---------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Moving head	Flexion	<p>Maximum backwards bending of the head: the person sits up and bends the head backwards. The angle from the vertical reference point to the fixed line in front of the ear is measured.</p> <p>Maximum forward bending of the head: the person sits up and bends the head forwards. The angle from the vertical reference point to the fixed line in front of the ear is measured.</p> 
	Rotation	<p>Maximum rotation of the head: the person sits upright and rotates the head to the left while looking forward. The angle from the horizontal reference point to the line from the back of the head through the nose is measured.</p> <p>Same procedure to the right</p> 
	Lateral Bending	<p>Maximum sideward bending of the head: the person sits upright and bends the head to the left while looking forward. The angle from the vertical reference point to the midline of the head is measured.</p> <p>Same procedure to the right.</p> 

Vertical Reaching	<p>Comfortable area of reaching in vertical plane: the person stands besides a vertical plane and marks the area that is: (a) within comfortable reach, with stretched right arm and without bending body forward (b) within maximum reach of the right arm, keeping both legs stretched and bending the trunk.</p>  <p>(a) (b)</p>
Grip	<p>A pole is hanged at the height of 1.80m from the floor (the average find on bus in London and in Brasilia).</p> <p>Output measure: impairment if participant cannot open their finger to grip the pole, impairment, otherwise, if participant can grip the pole.</p>
Step Height	
Walking speed	The normal speed measured along a fixed horizontal distance (10m).

The measured value is compared with the Steenbekkers and Beijsterveldt's ergonomic tables for each function. The participant output measure is categorised as 'impaired' if the measure is outside the interval established by the ergonomic table ($P5 \leq X \leq P95$) or 'not impaired' if the measure is within the interval.

Table 5.7 – Ergonomic Table: Range for Performance among Elderly People

Description	Men	Women
Balance (seconds)	$7.7 < x = 38.7 < 60$	$3.6 < x = 32.4 < 60$
Flexion Forward (degrees)	$11^\circ < x = 25^\circ < 41^\circ$	$11^\circ < x = 28^\circ < 50^\circ$
Flexion Backward (degrees)	$28^\circ < x = 44^\circ < 60^\circ$	$24^\circ < x = 48^\circ < 72^\circ$
Rotation to Right (degrees)	$46^\circ < x = 62^\circ < 78^\circ$	$41^\circ < x = 61^\circ < 72^\circ$
Rotation to Left (degrees)	$44^\circ < x = 60^\circ < 74^\circ$	$40^\circ < x = 60^\circ < 79^\circ$
Lateral bending to Right (degrees)	$15^\circ < x = 28^\circ < 46^\circ$	$22^\circ < x = 31^\circ < 45^\circ$
Lateral bending to Left (degrees)	$29^\circ < x = 30^\circ < 46^\circ$	$21^\circ < x = 29^\circ < 40^\circ$
Reaching (ST) Comfortable ²²	$(90\%) 60^\circ < x < 75^\circ (65\%)$	

²² % denotes the proportion of subject that reached the related radius°

50-74 years& stature<170cm	(10%) 55°	
50-74 years & stature >= 170cm	(90%) 60° < x < 75° (65%) (10%) 55°	
75+ years & stature < 165 cm	(86%) 60° < x < 75° (68%)	
75+ years & stature >= 165 cm	(78%) 60° < x < 75° (64%)	
Reaching (BEND) Maximum ¹ 50-74 years & stature<170cm	(97%) 45° < x < 90° (70%) (66%) 30°	
50-74 years & stature >= 170cm	(97%) 45° < x < 90° (67%) (68%) 30° < x < 75° (99%)	
75+ years & stature < 165 cm	(81%) 45° < x < 90° (36%) (47%) 30° < x < 75° (96%)	
75+ years & stature >= 165 cm	(86%) 45° < x < 90° (50%) (45%) 30° < x < 75° (98%)	
Grip (Practical test: D = 4cm at 1.93m)	3.7cm < x < 4.9cm	
Step (up) Comfortable (cm)	14 < x =20 < 28	14 < x=18 < 23
Step (up) Maximum (cm)	32 < x =44 < 50	23 < x =37 < 50
Step (down) Comfortable (cm)	14 < x =20 < 23	14 < x =17 < 23
Step (down) Maximum (cm)	32 < x =44 < 50	23 < x =37 < 50
Step length (cm)	65.9 < x=76.0 < 90.0	50.1 < x=64.4 < 79.0
Walking speed (m/s)	1.1 < x =1.4 < 1.6	0.9 < x =1.3 < 1.7

5.4.3 Test 2.3 - Functional Tests: Memory Tests

The memory test is divided according to the traditional distinction between Short Term Memory (STM) and Long Term Memory (LTM) (Atkinson & Shiffrin, 1968 and Waugh & Norman, 1965). The output considered necessary for the study is a measurement of individual memory competence without being trained and that is the reason why the classical tests of digit span for STM and recall/recognition for LTM were adopted in this phase of the experiment.

Tables 5.8 and 5.9 illustrate the tests used to check STM memory. For this study, STM is divided into Visual Memory and Audible Memory because it was understood that both are important for the acquisition of information. This division was supported by Vance & Singer (1979), Gathercole & Adams (1993) and Jaquith (1996). Both tests follow the traditional digit spam format. In the visual case, each participant was presented with a card with a sequence (starting with 3 letters) for a total of 3 seconds. Auditory spans were tested by playing a recorded sequence of letters to the participant. Each letter was dictated monotone with an interval of one second between them. Immediately after presentation, the participant was then asked to write down the sequence in the same order. If the sequence was repeated accurately, the test progressed to a sequence of letters that contained an additional one digit. This procedure was then repeated until the participant responded incorrectly, at which point the test was stopped and the digit span recorded as the highest correct sequence length. The classical average number remembered is 7 +/- 2, Miller (1956).

Table 5.8 – Battery Test: Short Term Visual Memory

Trial	# Letters	Correct Letters	Remembered	Score
1	3	UMP		
2	4	TZLD		
3	5	KXCEJ		
4	6	OAVCYI		
5	7	SLBFQRP		
6	8	XUAMZQEC		
7	9	JBUMONRVY		
8	10	NJVCOEMPWD		
9	11	LDGXHPQIROB		
10	12	HFPWZIDMANCU		

Table 5.9 – Battery Test: Short Term Auditory Memory

Trial	# Letters	Correct Letters	Remembered	Score
1	3	PMU		
2	4	DLZT		
3	5	JECXK		
4	6	IYCVAO		
5	7	PRQFBLS		
6	8	CEQZMAUX		
7	9	YVRNOMUBJ		
8	10	DWPMEOCVJN		
9	11	BORIQPHXGDL		
10	12	UCNAMDIZWPFH		

For the LTM task it was developed a general index to understand (spatial) long term memory competence derived by the average of correct answer in the three basic tests:

- i. Recall (allocation) of landmarks along the route (remembering the position of an item on the route); (weight 0.4)
- ii. Recognition specific landmarks from a broader set of landmarks and (weight 0.4)
- iii. Route recognition with rotation task embedded (weight 0.2).

The tests were tailored to examine spatial domain and they were based on Presson (1989) study about the importance of recognition of real landmarks along the route and

its representation (to allow recognition of a previously encountered area irrespective of the direction from it is seen).

For the recall of the landmarks, the format shown in Figure 5.4 was used: 10 pictures of landmarks along a route (A to B) were given to the participant who was asked to study the scene for 30 seconds. The landmarks are represented using a picture and textual reference. The route is fictional and although the pictures are from real landmarks around London and Brasília (depending on the case study) they are placed completely randomly along the notional route. Also, the reference names attributed to some pictures were created. A person who knows London or Brasília well would conclude that the notional route is quite impossible, because of the irrational sequence of landmarks.

The figure is then removed from the participant's view and he/she is immediately asked to reproduce the route with landmarks by memory. Figure 5.5 illustrates the format in which the participant is supposed to complete the test. The type of representation (pictorial or textual) selected by the participant is another output of the test.

For the picture recognition task, the 10 pictures used in Figure 5.4 were mixed with another 14 different landmark pictures. The whole set (24 figures) was then presented to participant who was asked to recognise ("Please write down the numbers of pictures you have recognised to belong to the route you have studied") the 10 pictures (randomly disposed in the 3x8 table).

The second task consists of recognition of the 10 landmarks pictures from a list of 24 pictures. The third test, the recognition task with rotation embedded, was to choose the correct route from a collection of 4 different routes rotated through different angles. The correct route is presented in a different orientation (Figure 5.6)

The final score was weighted: [50% to 25%] participant is considered to have a Mild LTM impaired and < 25%, a Moderate LTM impaired. Ideally with the replication of INFOChain a proper table should be constructed with consistent interval, taking into consideration participants' gender and age range, similar to the tables constructed by Steenbekkers and Beijsterveldt (1998).



Belsize Lane



The Column Church



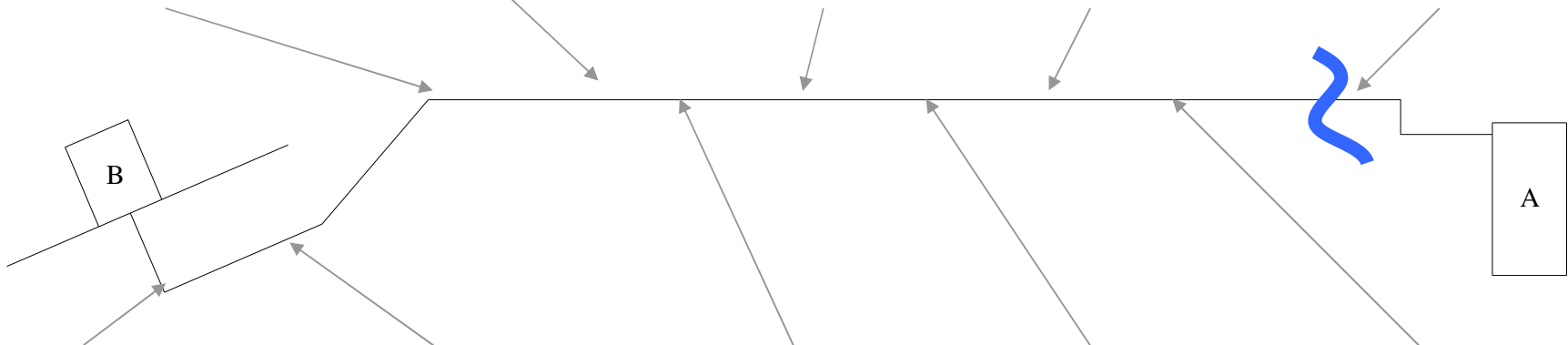
Planetarium



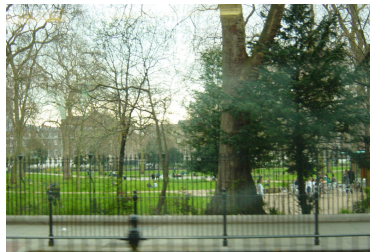
Marylebone Station



Waterloo Bridge



Old Lady Road



The Green Garden



Bush House



The Tower Church



Camden Town Station

Figure 5.4 – Battery Test: Long Term memory

Using references A (origin) to B (destination), please complete the route with landmarks you have studied.

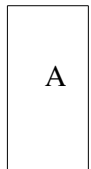
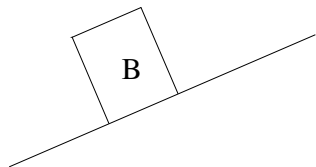


Figure 5.5: Battery Test: Format for Recall Pictures

Choose the correct route according to the picture you have studied.

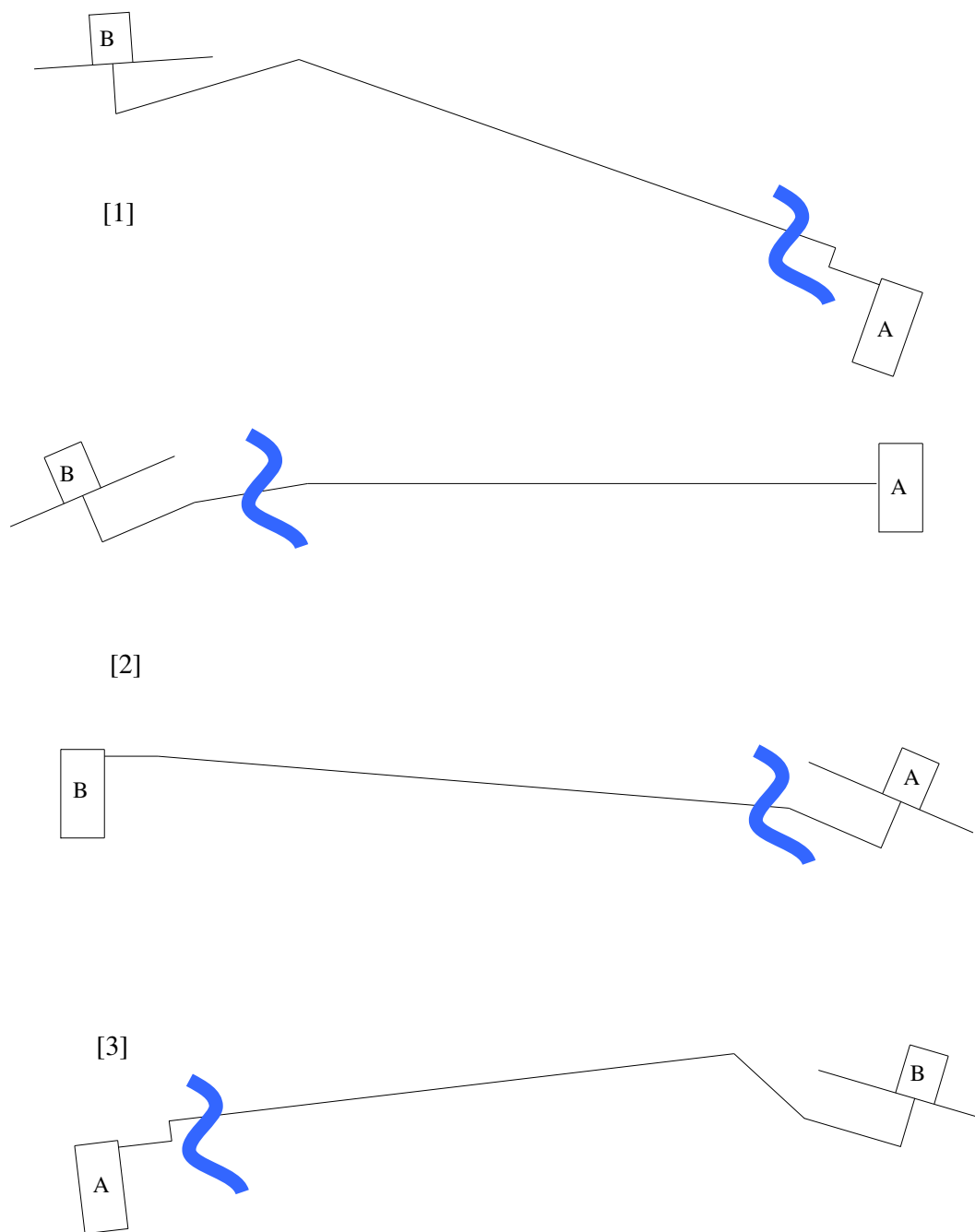


Figure 5.6 – Battery Test: The Recognition Test (Orientation)

5.4.4 Test 3 - The Imaginative Test

This test is divided into two kinds of measurements: a subjective test in which the participant is asked to use self-reported measures to make some kind of subjective assessment and an objective (quantitative) test in which the participant had to decide about dimension, orientation, and construction from the elements provided for the test. See Table 5.10.

The subjective test utilised a small multiple-choice questionnaire based on Huska-Chirroussel (2000). The questions aim to capture the capacity of generating a mental image (Imaginative Capacity) in which a higher score is awarded for a greater capacity for resolution of a spatial problem. Each item was represented to respondents in a multiple-choice format (following attitude scale construction developed by Likert (1932), such as: completely agree, partially agree, partially disagree, and completely disagree. No neutral question (undecided) was considered. Participants chose the alternative that best represents their degree of agreement or disagreement with the item. Each item received a score from 2 to -2 depending on the participant's degree of agreement or disagreement with it. The scores received for each item were then totalled to obtain the participant's total score on the attitude scale:

- [2] completely agree
- [1] partially agree
- [-1] partially disagree
- [-2] completely disagree





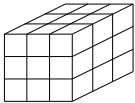
The final index was divided by the maximum number of agreement (12), so that each interval gives a level of imaginative competence

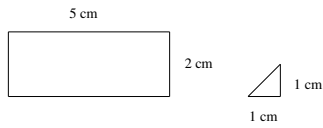
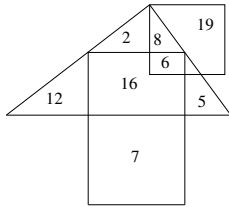
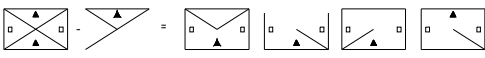
- [1.00] Total competence
-]1.00 to 0.75] Strong competence
-]0.75 to 0.50] Good competence
-]0.50 to 0.25] Medium/Weak competence
-]0.25 to 0.00] Very Poor competence

For the quantitative assessment, examples from Year 7 examination on mathematics and non-verbal reasoning were used because they use basic mathematical concepts and can be applied universally as the questions appear in diagrammatic or pictorial forms and are not language-based. In this kind of test, there is only one correct answer and the total score of correct answers is then computed.

As Sternberg (1983) mentioned, researchers need to be careful when evaluating if a person is good or bad at imagery. He noted that imagery is not a single ability. Rather, imagery is a collection of distinctive abilities such as the ability to rotate images, the ability to inspect them, the ability to hold many parts of an image at once, and so on. Further, people can be relatively ‘good’ at one or more of these abilities, and poor at others.

Table 5.10 – Battery Test: Imaginative Test

Subjective Part	
1. When a person tells me something that has happened to him/her, I can form the visual image of it.	<input type="checkbox"/> completely agree <input type="checkbox"/> partially agree <input type="checkbox"/> partially disagree <input type="checkbox"/> completely disagree
2. I have a very poor imagination	<input type="checkbox"/> completely agree <input type="checkbox"/> partially agree <input type="checkbox"/> partially disagree <input type="checkbox"/> completely disagree
3. Mentally representing objects in movement is difficult for me	<input type="checkbox"/> completely agree <input type="checkbox"/> partially agree <input type="checkbox"/> partially disagree <input type="checkbox"/> completely disagree
4. Mentally rotating objects is easy for me.	<input type="checkbox"/> completely agree <input type="checkbox"/> partially agree <input type="checkbox"/> partially disagree <input type="checkbox"/> completely disagree
5. I dream very rarely.	<input type="checkbox"/> completely agree <input type="checkbox"/> partially agree <input type="checkbox"/> partially disagree <input type="checkbox"/> completely disagree
6. When I lose my keys I can manage to retrace mentally the likely sequence of places where I could have left them.	<input type="checkbox"/> completely agree <input type="checkbox"/> partially agree <input type="checkbox"/> partially disagree <input type="checkbox"/> completely disagree
Objective part	
7. Take a square piece of paper, fold it in one half, then fold it in half twice more. How many squares exist after this final fold? (Gardner, 1983)	<input type="checkbox"/> 2 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 8 <input type="checkbox"/> 10
8. From the array of four choose that form that is identical to the target form (Gardner, 1983)	   
9. A cube with 3 cm is made from smaller cubes of side 1cm as shown. (Dulwich College - Mathematics Sample Examination) How many cubes are used in making the bigger cube? If the bigger cube is painted blue all over, how many small cubes will have three blue faces? How many small cubes share a face with 5 other small cubes? How many small cubes share a face with exactly 2 other small cubes?	

10) How many triangles of the size shown will fit into the rectangle below? (Emmanuel School – Mathematics Sample Examination)	
11) Which number is in all three shapes?	
12) One shape is subtracted from the other. The shapes do not turn. (Learning Together – www.learningtogether.co.uk)	

5.4.5 Test 4 - Language Preference

This test aims to capture the preferred mode of language revealed among:

- (W) Writing or textual mode: procedure descriptions
- (S) Schematic or Graphic Mode: plan/map utilization
- (P) Pictorial or Photographic Mode: representation of images

This test is based on an exercise developed by Huska-Chirroussel (2000) to analyse the correlation language preference and orientation performance in real environments. Each individual is considered predominant in one single mode (the highest index), which indicates the mode of preference of working with information. This does not mean that an individual will not be able to operate within different modes.

This test consists of 12 questions. The main format is multiple-choice with only one descriptive question (#9), as illustrated in Table 5.11.

Table 5.11 – Battery Test: Language Preferences

1. In general, visit exhibition, graphic art museum (photography, painting) is an activity that I do:	<input type="checkbox"/> never <input type="checkbox"/> very occasionally <input type="checkbox"/> occasionally <input type="checkbox"/> frequently
2. During an excursion (group of people travelling abroad) you prefer to:	<input type="checkbox"/> take pictures <input type="checkbox"/> use a city plan <input type="checkbox"/> talk about the places you visit
3. I enjoy walking around a city that I have never visited before just to experience the environment, the type of buildings, landscape and people.	<input type="checkbox"/> completely agree <input type="checkbox"/> partially agree <input type="checkbox"/> partially disagree <input type="checkbox"/> completely disagree

4. Generally when you arrive at an environment that you don't know, you find your way very easily.	<input type="checkbox"/> completely agree <input type="checkbox"/> partially agree <input type="checkbox"/> partially disagree <input type="checkbox"/> completely disagree	
5. I have a tendency to turn the map/plan to follow it when I am out (in a real environment).	<input type="checkbox"/> completely agree <input type="checkbox"/> partially agree <input type="checkbox"/> partially disagree <input type="checkbox"/> completely disagree	
6. You are walking around a city with which you are not familiar. You realise you are lost. What is your first reaction?	<input type="checkbox"/> Ask somebody for directions <input type="checkbox"/> Follow your intuition and try a direction <input type="checkbox"/> Look for and at a map or a plan <input type="checkbox"/> Get really nervous and upset without having a practical solution	
7. When you have an important appointment at an area you have never visited before, you:	<input type="checkbox"/> Plan everything about the journey so that you do not get lost or waste time. <input type="checkbox"/> Have a rough idea how to get there. Look for bus line to get on and work out where to get off. <input type="checkbox"/> Don't bother, get a taxi	
8. You sort out a trip in your private car. After 20 km you realize that you have forgotten your camera. You decide to:	<input type="checkbox"/> forget about pictures <input type="checkbox"/> buy a disposable one when you get to your final destination <input type="checkbox"/> return to pick it up	
9. A friend is coming to visit you (he has never come before to the city where you live). Tell him how to get to your house.		
10. A person is confronted with an administrative problem that you know quite well. She/He came to visit you so you can explain it to her/him. Explaining a situation that is apparently complicated is for you:	<input type="checkbox"/> A difficult task, because <input type="checkbox"/> A medium task, because <input type="checkbox"/> An easy task because	<input type="checkbox"/> you feel that you would not be understood. <input type="checkbox"/> you don't talk very much <input type="checkbox"/> you don't have problem in communication <input type="checkbox"/> other
11. How many books do you read per year?	<input type="checkbox"/> Only one <input type="checkbox"/> 2 to 10 <input type="checkbox"/> 10 to 20 <input type="checkbox"/> More than 20	
12. You have something important to tell a friend (but not necessarily urgent). You prefer to:	<input type="checkbox"/> Write a letter <input type="checkbox"/> Phone him	
13. When you write:	<input type="checkbox"/> I write directly <input type="checkbox"/> I write a draft, first <input type="checkbox"/> I work a lot on the draft version, changing words and sentences	
14. When you read a book, you can imagine the scenes:	<input type="checkbox"/> very precisely <input type="checkbox"/> precisely <input type="checkbox"/> approximately <input type="checkbox"/> I do not imagine any scene	
15. How often you go to the cinema	<input type="checkbox"/> Never <input type="checkbox"/> Once a year <input type="checkbox"/> Once every six months <input type="checkbox"/> Once every three months <input type="checkbox"/> Once a month <input type="checkbox"/> Once every 15 days <input type="checkbox"/> Once per week	
16. You go to the cinema	<input type="checkbox"/> as an excuse to go out <input type="checkbox"/> to see an specific actor/actress, director, theme <input type="checkbox"/> because you love the quality of the image <input type="checkbox"/> I don't go to the cinema.	

The final score indicate the preferred mode of language, the dominant between W, S, P.

5.4.6 Test 5 - Orientation: The Road Map Test - Right/Left

This test assesses the participant's visual spatial ability (the ability to keep a correct orientation and position with respect to a printed map) and is also applied to explore the domain of right and left side (Figure 5.7). The test scores the number of correct answers and the duration of the exercise. This test is also based on an exercise developed by Huska-Chirroussel (2000, p: 398).

With the plan of a city below, follow the numbers (1 to 9) telling which direction (L) Left or (R) Right you need to change. DO NOT TURN THE PAGE, please.

1	2	3	4	5	6	7	8	9

Figure 5.7 – Battery Test: The Road Map Test - Right/Left

The final index is the number of correct answers divided by 9 and is classified into:

[1.00]	Total competence
]1.00 to 0.75]	Strong competence
]0.75 to 0.50]	Good competence
]0.50 to 0.25]	Medium/Weak competence
]0.25 to 0.00]	Very Poor competence

5.4.7 Test 6 – Orientation Test – Drawing with perspective

This test was developed to assess the individual dominance of body axes. According to Bryant, Tversky and Franklin (1992) the internal spatial framework is formed from the observer's body axes and the external framework from a set of axes projected from the observer. The framework is a 'mental scaffold' on which specific information can be arranged and rearranged. The problem space representation is related to the type of framework being activated (egocentric, intrinsic or extrinsic).

This test is a very simple version of the complex experiment conducted by Bryant (1999) about the spatial framework model. A box drawn in perspective is shown to the participant, who is then asked to assume that they are located in the position occupied by the figurative person inside the box and to draw the symbols in the correct place in the diagram (Figure 5.8). A 'template of tolerance' around the object locations is adopted to standardize the answers. The final index is related to dominance and is obtained by dividing the number of correct drawings divided by 6 (the number of figures to be drawn). The resulting score is then classified into:

[1.00]	Total competence
]1.00 to 0.75]	Strong competence
]0.75 to 0.50]	Good competence
]0.50 to 0.25]	Medium/Weak competence
]0.25 to 0.00]	Very Poor competence

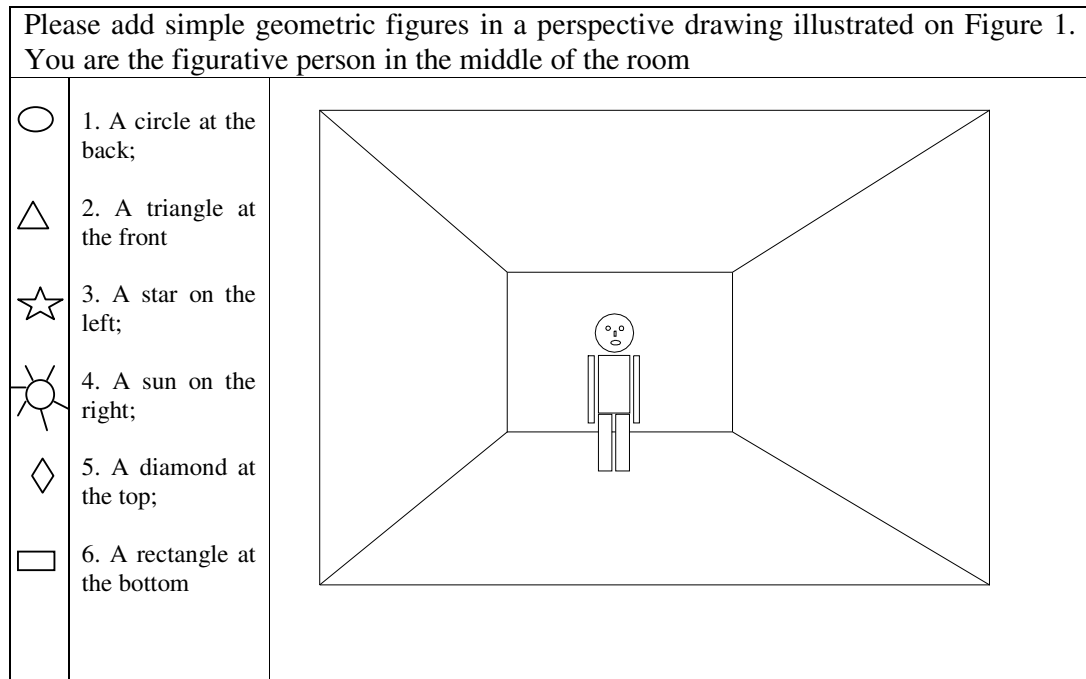


Figure 5.8 – Battery Test: Drawing with perspective

5.4.8 Test 7 – Spatial Orientation (Place Cognition: City Knowledge)

This test was based on place cognition principles: the individual's overall cognition of specific location. "Place cognition is investigated by researchers who want to explain commonalities and divergences between participants in the same environment".

(Kitchin and Blades 2002, p: 163). In the INFOChain experiment, it tests participant's estimation of distance and direction from one constant origin (UCL/UnB, where all the experimental journeys depart) to 8 common tourist points and it was used to represent the participant's spatial knowledge of the city centre and immediate areas.

Each participant was asked to plot inside a circle marked with cardinal points (N, S, E and W) eight tourist places of London or Brasília as appropriate (Figure 5.9). The participant was asked to consider that UCL (or UnB) – i.e. the place where he/she is doing the test – is located at the centre of circle. Each point has its direction and distance from the centre point measured. The direction tolerance is $\pm 10^\circ$ and the tolerance for distance is ± 10 units. The participant scores 1 point for correct direction and one point for correct distance of their attempt inside the tolerance interval. The final index is obtained by the sum of correct locations divided by 16, (the maximum level of correct points). The classification is made according to four levels:

- 1.00] Total competence
]1.00 to 0.75] Strong competence (Very good knowledge of the city)
]0.75 to 0.50] Good competence (Good knowledge of the city)
]0.50 to 0.25] Medium/Weak competence (Medium knowledge of the city)
]0.25 to 0.00] Very Poor competence (Poor knowledge of the city)

Plot those tourists reference on the cardinal system above. You are at the centre, at UCL. The numbers need to be written inside the circle.	
1. Royal Albert Hall 2. Camden Town Market 3. Science Museum 4. Barbican Centre 5. House of Parliament 6. Nelson's Column 7. Regent Park 8. Tower Bridge	

Figure 5.9 – Battery Test: City Knowledge

The level of accuracy obtained in this test is presented in Table 5.12

Table 5.12 – Level of Accuracy in Place Cognition Test

City	Participant	% Correct answer obtained	Number of correct direction estimation	Number of correct direction estimation	Total
UK	Male 01	63%	4 in 8	6 in 8	10 in 16
	Male 02	31%	0 in 8	5 in 8	5 in 16
	Female 01	31%	1 in 8	4 in 8	5 in 16
BR	Female 01	38%	2 in 8	4 in 8	6 in 16
	Female 02	18%	0 in 8	3 in 8	3 in 16
	Female 03	13%	0 in 8	2 in 8	2 in 16

Table 5.12 shows that for most of the participants the score obtained in distance estimation is higher than for direction estimation. According to the classification adopted, most of the participants were classified as having medium to weak knowledge of the city. The test was considered difficult for both participants and the researcher. The difficult is due to the concept of the scale inbuilt by the circle boundary imposed by

the test and the fact that origin fixation (UCL/UnB) was not the participant's natural way to construct spatial knowledge about the city.

The test is used as one element to evaluate cognitive capacity (Table 5.18). More participants should be tested in order to achieve the validity standards recommended by Kitchin and Blades (2002). Moreover there is a need to verify how the same participant would carry out the same estimation task at different times.

5.4.9 Test 8 – Participant's subjective and objective opinion about Transport System

This test captures the participant's impression about the transport system (Table 5.13). The first 12 questions cover opinions about the transport system and their knowledge about the bus and underground systems. The questions vary in format: 3 of them are in multiple-choice format and the rest are open questions requiring a written answer. The twelfth question follows the format of a sentence completion test, suggested by Rhode (1957). This is a type of projective²³ (or free-response) question mostly used in psychology. The response is considered to be a projection of the participant's conscious and/or unconscious attitudes, personality characteristics, motivations, and beliefs. The last test output is a number, a grade for the bus system.

Table 5.13 – Battery Test: Participant's knowledge a Transport System

1. What is the best mode of transport in your opinion?	
2. What do you think about the London public transport system?	
3. How many lines does the London Underground system have?	<input type="checkbox"/> 5 <input type="checkbox"/> 10 <input type="checkbox"/> 12 <input type="checkbox"/> More than 15
4. To go to Buckingham Palace which line should I take and which bus stop/station should I stop?	
5. How many service lines does the London bus system have?	<input type="checkbox"/> around 100 <input type="checkbox"/> around 500 <input type="checkbox"/> around 800 <input type="checkbox"/> More than 800
6. Can you tell me 3 bus lines that go to Oxford Street?	
7. How much is an underground one-day travel card in London?	
8. How much can you pay for one bus ticket if you buy a bus ticket saver package?	
9. How often do you use buses?	<input type="checkbox"/> Never <input type="checkbox"/> Occasionally <input type="checkbox"/> More than twice a week <input type="checkbox"/> Everyday
10. List occasions do you decide to use the bus system.	
11. What do you think about bus system in London?	A good point: A bad point:

²³ A projective test, in psychology, is a personality test designed to let a person respond to ambiguous stimuli, presumably revealing hidden emotions and internal conflicts.

12. Please complete: Use train in London is: Walk in London is: Use underground in London is: Bike in London is: Use a bus in London is:										
13. Please give London Bus System a grade										
0	1	2	3	4	5	6	7	8	9	10
Appalling			Reasonable					Excellent		

5.4.10 Test 9 – Introspective report about a journey by bus

This test explores the participant's 'natural way' to deal with the problem of doing a journey by bus. Problem solving strategies, informally described as 'ways to solve a task', consist of any strategy created to deal with the four dimensions of the problem: the initial state (where are you and what do you want to do), the goal state (where do you want to go), the legal operator (things that participant is allowed to do) and the operator restrictions (factors that constraint the application of operators, time).

The test follows an open interview approach. The idea is to capture the first strategy that the participant uses to develop the task (plan a journey to an unfamiliar environment - a hospital never visited before). The choice of hospital characterises a place that he/she needs to go because he/she has been waiting for the appointment for some months. It is an important journey that cannot be postponed (Table 5.14).

Table 5.14 – Battery Test: Strategy to compose a journey using public transport

<p>"Imagine that you have a medical appointment at a hospital in an area that you have never visited before. This appointment is very important for you. You have been waiting for it for three months.</p> <p>What do you think it is important for you to know in order to do this journey? What are the steps that you might follow to complete this task. Please, describe it remembering any kind of information or service you would use."</p>

5.4.11 Test 10 - Risk Perception and Risk Behaviour

According to Weber (2002), the attitude-scale distinguishes between two psychological variables: risk perception ('not risky at all' to 'extremely risky') and attitude toward perception ('extremely unlikely to engage (averse)' to 'extremely likely to engage (seek)'). Like Weber, Sitkin and Weingart (1995), Lopes (1987) March and Saphira (1992), Ajzen and Fishbeins (1992) also believe that "risk taking is content specific and that domain as well as personality variables (e.g. gender, tolerance) in risk taking are as

much (or more) of a function of difference in risk perception than of differences in attitude towards perceived risk” (Weber 2002, p: 264).

Another important difference is the purpose of the investigation. According to Weber, “for prediction purposes it is immaterial whether observed behaviour is the result of the participant’s beliefs about the riskiness of the choice or of their attitude towards (perceived) risk. However, this distinction becomes important when one assesses a person’s risk-taking with the goal of changing their risk-taking behaviour.” (Weber 2002, p: 267).

A similar test conducted by Weber (2000) was designed to measure risk attitude related to its two dimensions: risk perception and risk behaviour, concentrating on different phases of the journey chain. Twenty-five risk-taking situations were presented (5 for planning, 5 for walking, 5 for getting on/off and the last five for riding). For each statement in Table 5.15, the participant is asked to indicate how risky they perceive each situation, providing a rating from 1 to 5. For each statement in Table 5.16, the participant is asked to indicate the likelihood of engaging in each activity or behaviour, providing a rating from 1 to 5.

Total scores show perception towards a journey by bus and the tendency of behaviour (risk averse to risk seeking). The contents of the risk situation were based on a literature review on hazards and obstacles along the journey chain: Oxley (2000), Ritter *et al.* (2000), Oxley and Gallon (1995), DETR (1999), DETR (2001) and Caiafa (2004). Most of the statements put the participant as an active controller of the situation. However, statements number 8 and 10 (related to the walking stage) and 24 and 25 (related to riding stage) are not under the participant’s control (passive actor). They are related to the environment specificities and capture the participant’s feelings about the probability of occurrence of those types of situation while doing a journey by bus.

The Weber approach was used in this study to capture which stages along the journey would be considered difficult for the individual. If a detailed analysis is needed to establish individual differences or any consideration about gender differences, a careful examination is recommended to study the effect of the inbuilt concept of passive and active actors (the effect of the wording) in the outputs. An extension of the sample size is certainly recommended.

The outputs of the original test are presented in Chapter 7 and 8.

Table 5.15 – Battery Test: Risk Perception









A) For each of the following statements, please indicate how risky you perceive each situation. Provide a rating from 1 to 5 using the following scale.					
	1	2	3	4	5
	Not at all risky		Moderately		Extremely Risky
Scale	Situation/Statement				
	1 - Going around a city that I have never visited before.				
	2 - Asking somebody for direction.				
	3 - Going on a trip to an unfamiliar environment without planning.				
	4- Doing a trip to an unfamiliar environment on your own.				
	5- Going out with the exact amount of money to travel and come back.				
	6 - Stepping out of the road without taking into account the traffic.				
	7 - Crossing a road while WAIT sign.				
	8 - Getting knocked by bicycle on the footway.				
	9 - Walking home alone at night.				
	10 - Falling down on an uneven footway surface.				
	11 - Talking to a stranger that approaches you.				
	12 - Leaving your bag unattended while checking details on timetable.				
	13 - Buying ticket from a stranger.				
	14 - Waiting for the bus on the wrong side of the road				
	15 - Misreading the bus number.				
	16 - Getting on/off while the bus is moving.				
					
	Situation 17 – Getting on <input type="text"/>		Situation 18 – Getting on <input type="text"/>		
					
	Situation 19 – Getting off <input type="text"/>		Situation 20 – Getting off <input type="text"/>		
	21 - Moving inside the bus while it is moving				
	22 - Getting off at wrong bus stop				
	23 - Leaving your bag unattended inside bus.				
	24 - Being mugged/assaulted inside the bus.				
	25 - Being diverted from your original planned journey				

Table 5.16 – Battery Test: Risk Behaviour

B) For each of the following statements, please indicate the likelihood of engaging in each activity or behaviour. Provide a rating from 1 to 5, using the following scale:					
	1	2	3	4	5
	Very Unlikely	Unlikely	Not sure	Likely	Very Likely
Scale	Situation/Statement				
	1 - Going around a city that I have never visited before.				
	2 - Asking somebody for direction.				
	3 - Going on a trip to an unfamiliar environment without planning.				
	4- Doing a trip to an unfamiliar environment on your own.				
	5- Going out with the exact amount of money to travel and come back.				
	6 - Stepping out of the road without taking into account the traffic.				
	7 - Crossing a road while WAIT sign.				
	8 - Getting knocked by bicycle on the footway.				
	9 - Walking home alone at night.				
	10 - Falling down on an uneven footway surface.				
	11 - Talking to a stranger that approaches you.				
	12 - Leaving your bag unattended while checking details on timetable.				
	13 - Buying ticket from a stranger.				
	14 - Waiting for the bus on the wrong side of the road				
	15 - Misreading the bus number.				
	16 - Getting on/off while the bus is moving.				
	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>Situation 17 – Getting on <input type="text"/></p> </div> <div style="text-align: center;">  <p>Situation 18 – Getting on <input type="text"/></p> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;">  <p>Situation 19 – Getting off <input type="text"/></p> </div> <div style="text-align: center;">  <p>Situation 20 – Getting off <input type="text"/></p> </div> </div>				
	21 - Moving inside the bus while it is moving				
	22 - Getting off at wrong bus stop				
	23 - Leaving your bag unattended inside bus.				
	24 - Being mugged/assaulted inside the bus.				
	25 - Being diverted from your original planned journey				

5.4.12 Test 11 - Post Interview Test

Three questions are presented to the participant in order to evaluate their level of understanding of the exercise. The questions are based on recommendations of authors on the study of experimental psychology (e.g. Arosen (1990) and Christensen (1994)). They cover aspects such as: confusing points in the experiment, criticisms and suggestions for improvements and the level of difficulty of understanding the task.

Table 5.17 – Battery Test: Post Interview Test

1. Are there any aspects of the procedures that you have found odd, confusing?										
2. Are there any aspects that you can suggest to improve experiment?										
3. In general, have you found difficulties to understand the information transmitted to you?										
0	1	2	3	4	5	6	7	8	9	10
No difficult										
Very difficult										

5.5 ANALYSIS OF BATTERY TESTS

From the literature review, it would be necessary to apply the battery test on a large sample population, identify manifested and latent variables, extract variance and covariance of each variable, study their behaviour and choose one of the methods of multivariate analysis: path analysis, factor analysis, and structural equation analysis. However, the purpose of this study is to concentrate on the individual's responses and not an aggregation of these into a population-wide study. Therefore, instead of traditional statistical analysis, the variables extracted from each participant compose that individual's capability provision and these will be compared with Required Capability determined for the specific environment.

The outputs extracted by physiological and psychological standards are qualified following the equivalences established in Table 5.18.

The tests are then summarised into an individual report about the participant, stressing his/her main functional capabilities and limitations and their subjective opinions about bus systems. It is important to reiterate that the results of these tests were only analysed

at the end of each case in order to minimize the potential risk of bias that such knowledge could introduce into the interpretation of the research.

This individual capability provision will then be compared with environment capability (required) to evaluate the participant's potential to execute the journey tasks proposed in the real environment. The analysis of environment condition is presented in the next section. The actual output of the interaction between participant and environment is presented in Section 5.7.

5.6 ANALYSIS OF THE ENVIRONMENT CONDITIONS

The analysis of environment conditions consists of the aspects involved in the moving phase of the journey chain (Figure 2.2 and Figure 4.14): the execution of the journey from UCL to a destination hospital in a real-life situation: As explained in Chapter 4, each stage of the journey is composed of subtasks (Table 4.6). Each subtask demands a level of effort depending on the environment conditions (ECr).

The effort required to do the subtask is divided in five categories, from “high effort” to “very low effort”, as illustrated in Table 5.18. The first level can be interpreted as follows: in order to complete a subtask that demands high effort, it is necessary that individual has no physical or sensory impairment or mild physical or sensory impairment. At the same time, the individual needs total or strong cognitive capacity to deal with this task (without assistance from a third person). The effort level is related to the journey environment (environment capability required to complete the subtask).

The categorization of the conceptual levels of effort was defined by a specialist panel composed by five researchers with experience in transport studies (1 doctor and 2 PhD students and 2 graduated researchers) during the pilot exercise.

In this study both objective and subjective approaches were used to judge the effort demanded in the real environment. The objective measures consisted of investigations at the site such as: walking distance, footway inclination, number of changes in direction, type of crossing, absence or presence of a dropped kerb, type of tactile surface at a dropped kerb, presence or absence of audible or tactile signs, bus stop layout,

special kerbs at bus stop, size of bus stop, among others. Each stage of each journey (B1, T1, T2, T3 and B2) has its own set of physical and psychological features which were collected in real environment tours. The subjective measures consist of e.g.: a sense of security, illumination, pedestrian density and they represent the psychological aspects of the environment.

Table 5.18 – Environment Level required and Individual Component Level Tolerated.

Environment Level Required	Individual Levels	
Effort required to do the subtask	Physical/Sensory Level Tolerated	Cognitive Level Tolerated
High effort	[0.00] No impairment	[1.00] Total competence [1.00 to 0.75] Strong competence
Great effort	]0.00 to 0.25] Mild impairment	]0.75 to 0.50] Good competence
Medium effort	]0.25 to 0.50] Moderate impairment	
Low effort	]0.50 to 0.75] Severe impairment	]0.50 to 0.40] Medium competence]0.40 to 0.25] Weak competence
Very low effort	]0.75 to 1.00] Profound impairment	]0.25 to 0.00] Very Poor competence

As explained in Chapter 4 (Table 4.6), each stage of the journey is composed of a set of subtasks (attributes) and each subtask requires a capability domain which is decomposed into individual functions that the participant needs to use in order to execute the subtask. The complete set of the individual body function x subtasks is presented on Table 5.19.

Table 5.19 - Relation between Stage-Subtasks and Individual Body Functions

Activity (Journey Stage)	Activity (Sub-Task) Information to Load	Individual Capability Provision (ICp)	
		Capability Domain	Function (Test)
Walking to Bus Stop	Path identification Information Availability	Sensory - Vision	Near vision acuity
			Colour acuity
	Path Identification Information Interpretation	Cognitive	Imaginative capacity
			Short Memory capacity
			Long Memory capacity
			Spatial capacity
			Knowledge PT
			Gen. Cognitive Index
	Distance (time) to walk	Physical	Balance
			Walking speed
	Footway Conditions	Physical	Balance
	Crossfall	Physical	Balance
			Walking speed
	Crossing Points	Sensory – Vision	Long Distance acuity
			Contrast-Sensitivity
			Colour acuity
			Stereotest
		Sensory - Hearing	Hearing Test

		Physical	Head-movement
			Walking speed
	Barrier Identification	Sensory – Vision	Peripheral Vision test
			Long Distance-acuity
			Contrast-sensitivity
			Colour-acuity
			Stereotest
		Physical	Balance
			Head-movement
			Step-height
	Safety issues – (information availability)	Sensory - Vision	Near vision acuity
	Safety issues – (information interpretation)	Cognitive	Long Memory Capacity
			Imaginative Capacity
			City Knowledge Capacity
	Orientation signs	Sensory – Vision	Distance-acuity
			Contrast-sensitivity
		Physical	Head-movement
		Cognitive	Spatial capacity
			Long Memory Capacity
Waiting	Bus Stop Identification - (information availability)	Sensory - Vision	Near vision acuity
	Bus Stop Identification - (information interpretation)	Cognitive	Short Memory Capacity
			Long Memory Capacity
			Spatial capacity
		Sensory - Vision	Long Distance acuity
	Bus Stop layout	Sensory - Vision	Long Distance acuity
		Cognitive	Imaginative Capacity
	Safety issues – (information availability)	Sensory - Vision	Near vision acuity
	Safety issues – (information interpretation)	Cognitive	Long Memory Capacity
			Imaginative Capacity
			City Knowledge Capacity
	Waiting environment	Sensory - Vision	Near vision acuity
	Waiting time – (information availability)	Sensory - Vision	Long Distance acuity
			Near vision acuity
	Waiting time – (information interpretation)	Cognitive	Imaginative capacity
Getting On	Gap Negotiation	Sensory – Vision	Stereotest
		Physical	Balance
			Head-movement
			Step-height
	Bus Service Identification - Information Availability	Sensory - Vision	Long vision acuity
	Bus Service Identification - Information Interpretation	Cognitive	Short Memory Capacity
			Long Memory Capacity
			Imaginative capacity
			Spatial Capacity
	Bus Type	Sensory - Vision	Near vision acuity
	Cost	Cognitive	Imaginative capacity
Riding	Landmarks References (Information availability)	Physical - Movement	Head-movement
			Balance
		Sensory - Vision	Long Distance-acuity
			Contrast-sensitivity
	Landmarks References (Information interpretation)	Cognitive	Long Memory Capacity
			Spatial capacity
	Direction (Information	Physical-Movement	Head-movement

	availability)		Balance
		Sensory - Vision	Long Distance-acuity
			Contrast-sensitivity
	Direction (Information interpretation)	Cognitive	Long Memory Capacity
			Spatial capacity
	Distance (time or km) (Information availability)	Sensory - Vision	Near vision acuity
	Distance (time or km) (Information Interpretation)	Cognitive	Imaginative capacity
			Spatial capacity
	Keep stability inside bus	Physical	Balance
			Reaching test
			Grip test
Getting Off	Landmarks References (Information availability)	Physical	Head-movement
			Balance
		Sensory – Vision	Long Distance-acuity
	Landmarks References (Information interpretation)	Cognitive	Contrast-sensitivity
			Long Memory Capacity
			Spatial capacity
	Bus Stop Identification - (information availability)	Physical	Head-movement
			Balance
		Sensory - Vision	Long Distance-acuity
	Bus Stop Identification - (information interpretation)	Cognitive	Contrast-sensitivity
			Long Memory Capacity
			Spatial capacity
	Gap	Physical	Balance
			Head-movement
			Step-height
	Bus Stop layout	Sensory – Vision	Stereotest
		Sensory - Vision	Long Distance acuity
		Cognitive	Imaginative Capacity
Walking to Destination	Path identification Information Availability	Sensory - Vision	Near vision acuity
			Colour-acuity
	Path Identification Information Interpretation	Cognitive	Imaginative capacity
			Short Memory capacity
			Long Memory capacity
			Spatial capacity
			Knowledge PT
			General Cognitive Index
	Orientation signs	Physical	Head-movement
		Sensory – Vision	Long Distance-acuity
			Contrast-sensitivity
	Distance to walk	Cognitive	Long Memory Capacity
			Spatial capacity
	Footway Conditions	Physical	Balance
	Crossfall	Physical	Balance
			Walking speed
	Crossing Points	Sensory – Visual	Long Distance acuity
			Contrast-Sensitivity
			Colour-acuity
			Stereotest
		Sensory - Hearing	Hearing Test
	Barrier Identification-Negotiation	Physical	Head-movement
		Sensory – Vision	Peripheral Vision test

			Long Distance-acuity
			Contrast-sensitivity
			Colour-acuity
			Stereotest
		Sensory - Hearing	Hearing Test
		Physical	Balance
			Head-movement
			Step-height
		Cognitive	Spatial capacity
	Safety issues – (information availability)	Sensory - Vision	Near vision acuity
	Safety issues – (information interpretation)	Cognitive	Long Memory Capacity
			Imaginative Capacity
			City Knowledge Capacity
	Target (Hospital) identification	Sensory – Vision	Long Distance acuity
			Contrast-sensitivity

Table 5.20 details the example of the “Getting on” stage. To complete the Getting on stage it is necessary to execute four subtasks:

- i. negotiate the gap,
- ii. identify the bus service to get on,
- iii. identify the bus type to get on and
- iv. be aware of the fare to pay inside the bus.

In this specific stage (of the example-journey in a London Environment) the negotiation around the gaps requires very high (or large) effort because the bus stops are not adapted to deal with the low floor buses and the drivers are not trained to park near the kerb.

The identification of the ‘Bus Service (number)’ is divided in two domains: the sensory domain (vision: able to see the number) and the cognitive domain (the interpretation of the service (number), the confirmation of direction). In terms of the sensory domain, the subtask demands medium effort because the information is available: buses are standardised and the number (bus-service) is presented in a reasonable size in different places of the bus (the front, the back and at the left side). In terms of the cognitive domain, the subtask demands medium effort because the information about the direction of the bus is available at bus stop (spidermap), the individual’s effort is to confirm the direction he/she wants to go.

In relation to the type of bus and the specific service number the effort is very low (or null) because all buses (vehicle) are accessible (step-free, space for wheel-chair users). In relation to costs, the effort is also very low (or null) because all participants all older than 65 years and they are conscious of their eligibility for a free bus pass.

Table 5.20 – Subtask Example: ‘Getting On’ Stage

Journey Stage	Subtask (Table 4.6)	Environment Condition (ECr)		Individual Condition (ICp)		ICp	ECr	Result
		Physical Features and Information Availability	Effort Demand (Table 5.18)	Capability Domain	(Body) Function			
Getting On	Gap Negotiation	HG>>200mm VG>> 75 mm	High effort or Large effort	Sensory – Vision	Stereotest	1.00	< 0.25	F
				Physical	Balance	0.00	< 0.25	T
					Head-movement	0.00	< 0.25	T
					Step-height	0.00	< 0.25	T
	Bus Service Identification - Information Availability	Large number and direction at the front of the bus	Medium effort to get them	Sensory - Vision	Long vision acuity	0.00	< 0.50	T
	Bus Service Identification - Information Interpretation	Confirmation of bus number and direction of service	Medium effort: Confirm direction.	Cognitive	Short Memory Capacity	1.00	> 0.50	T
					Long Memory Capacity	0.24	> 0.50	F
					Imaginative capacity	0.81	> 0.50	T
					Spatial Capacity	0.87	> 0.50	T
	Bus Type	Information about type of the bus (low floor, wc accessible)	Very low effort or no effort, information is given in printed and digital forms	Sensory - Vision	Near vision acuity	0.20	< 0.75	T
	Cost	Participants > 65 are eligible for free pass	Very low effort or no effort	Cognitive	Imaginative capacity	0.81	> 0.25	T

The Capability Model (Section 2.5 of Chapter 2) is then applied and the last three columns (ICp, ECr and their comparison ICp:ECr) of Table 5.20 illustrates how this application works. The individual capability provision (ICp) is compared with environment capability required (ECr). If the result of comparison between $ICp > ECr$ is false (F), the individual might have a problem overcoming the subtask. The result indicates a deviation between capabilities. The occurrence of a deviation makes the subtask mandatory. This means that the participant must search for information to cope with the deviation. The fact that she/he might not have been conscious of this deviation can be addressed in the training programme specifically tailored for this person. However the output of the interaction between ICp and ECr is computed and is used to construct the individual Deviation Curve (further explanation in Section 5.7).

For example, it was established that, for gap negotiation, the sensory (vision) and physical domains were to be compared. The main sensory function demanded to complete this subtask was the stereopsis which was tested by the stereotest. The most important functions related to physical domain were: balance, head movement and ability to mount a given step height. The outputs of each function are extracted from the individual report of battery test. From Table 5.20 it can be seen that the two subtasks (gap negotiation and bus service identification) demands more than the participant could cope. Therefore some form of coping strategy (compensation) is expected that could deal with the deviation, which for this study, is translated into the selection of information units to plan and execute the journey, which in turn is the awareness of information.

The Deviation is a conceptual representation of the requirements of information for a specific individual related to a specific stage of a specific journey. It captures what the participant with his/her individual capabilities should select and process in order to deal with the Environment Capabilities Required to complete each stage of the journey.

Again, depending on the result of the comparison between individual capabilities and environment capabilities, the use of information to cover the specific subtask would be relevant to the participant for completing the stage. If $ICp > ECr$ then the individual has a chance to execute the activity without great problems. If not, the chances are reduced until the activity cannot be executed or has to be cancelled. The information load could reduce the chances of failure at each specific stage along the journey.

5.7 THE DEVIATION CURVE

The conceptual requirement of information using the ‘getting on’ example is illustrated in Table 5.21. A brief description of the stage in real condition (Environment Inventory) is presented to illustrate the degree of the effort to overcome. The ‘Gap’ and ‘Bus Type’ are considered to be AI_type information. ‘Bus Service (number) Identification’ and ‘Cost’ are considered E_Type. Therefore, the **maximum** amount of information is 4 (four pieces) and the **minimum** is 2 ($E=2$ plus $T=0$). On the participant’s side (Individual Capability): the Battery Test reveals the impairments and competence (related to this stage). Subjective values about the risk and knowledge of the area and the note description exploring evidence for the need for information complements the analysis of the individual’s information needs. Therefore, this participant needs to collect the extra piece of information to deal with gaps, due to the **deviation** found when the comparison ICp:ECr was applied.

The process is repeated for each stage of the Journey Chain and for every participant-journey pair and a curve is constructed. The curve is represented by a radar diagram where each stage (Walking to Origin, Waiting, Getting On, Riding, Getting Off and Walking to destination) of the journey acts like a feature of the journey. An example is shown in Figure 5.10 where the journey has 7 stages and 7 features. The number along each axis reveals how many aspects – in other words, how many INFOChain subtasks (see Chapter 4, Table 4.8) of each stage - were covered.

The maximum, the minimum and the deviation curves constitute the first three dimensions of the journey, illustrated in Figure 5.10.

The output of the interaction between ICp and ECr, the deviation curve is then compared with the outputs captured when the participant selects, processes and uses the information (The Pre-Journey, The In-Journey and the Post Journey Curve) obtained with the second phase of SCA/CM procedures (Table 5.1), explained in Chapter 6.

Table 5.21 – The Construction of Deviation Curve

Environment Inventory (Getting on stage)	The Conceptual Requirement of Information				
<p>The traffic flow is heavy at this bus stop. Because bus stop serves many lines there are some congestion. Drivers tend to park far from the bus stop pole. Platform is not long enough to accommodate buses neither it is adapted for low floor buses. Platform is not wide enough to accommodate users. Gaps measured in locus were far from the minimum recommended.</p> <p>* Bus type is a type of information that demands previous knowledge. If participant has a physical impairment that might be important.</p> <p>Recommendation at site: Environment needs urgent modifications: platform layout should be modified to at least half-boarder type or should be shifted to a better location.</p>	Getting On (1 st Refinement) [ICp : ECr]		Information Expected (2 nd Refinement)	Individual Capabilities (Outputs from Battery)	
	#	Sub-Tasks	Type	Elements	Level
	1	Gap	AI	1	Stereopsis Severe Impairment [1.0]
	2	Bus Service	E	1	Long Memory Capacity Weak Competence [0.24]
	3	Bus Type	AI	0	Risk of Stage Mild [2]
	4	Cost	E	1	Declared knowledge of the area High [10]
				Difficulties reported Oral Interview	None
				Note: Although the risk feeling towards this stage is mild, participant has problems in terms of vision-depth and has declared problems on inferior members (ankle). Therefore information about Gap (#1) is expected (Value = 1). His weak LTM competence can be compensated by available information at bus stops.	
		Essential:	2		
		Time:	0		
		AI:	2		
		Total E+T:	2		
		Max:	4	Total: 3	

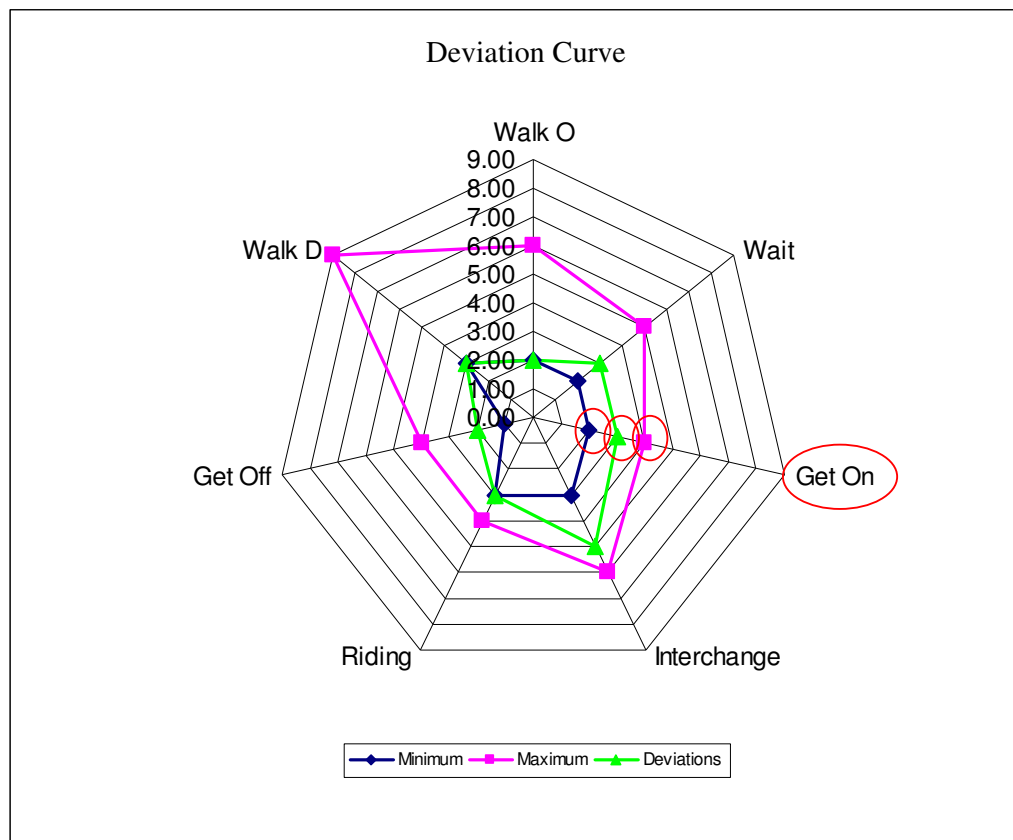


Figure 5.10 – Dimensions of Journey Chain: The Deviation Curve

The application of the Capability Model is flexible enough to include and/or exclude any attributes as well as to vary the scale of effort demanded. What is important is that the same classification is maintained for every participant during the experiment. The conceptual curve acts as a benchmark with which to compare the participant's use of information while planning (selection/process) and executing the journey (use).

At this stage of the methodology presentation some important issues need to be addressed:

- i. The definition of the stages that compose the journey (the stages along the Journey Chain, Figure 2.1);
- ii. The subtasks that compose each stage (Attributes/subtasks of each stage, Table 4.6)
- iii. The function that is related to each subtask (Body Function associated to each subtask, Table 5.19);
- iv. The definition of the table of effort (Table 5.18) and
- v. The judgement about the effort demanded by each subtask (high, medium, low, very low effort) in each environment (London and Brasília) which will affect the construction of the Deviation curve for each participant in each environment

are assumptions, made with the support of the literature review demonstrated in Chapter 2, 3 and 4, to assemble a new methodology to analyse the original question: how people use information, how individual decides which information he/she will select and process in order to find his/her way in real environment. After the analysis of the experiment results, some considerations were made and they are discussed in Chapter 7, 8, 9 and 10.

5.8 CONCLUSIONS

A detailed battery test was established to explore individual differences due to the applicability of the information system for public transport. There are two principal reasons for adopting a battery test approach. First, it is important to understand the individual characteristics of “the public” for whom a Public Information System is designed. Secondly the battery tests are important because the study of individual features is a sub-objective of the present study (relation between capabilities x information type).

A good knowledge of who is being examined becomes a key factor for investigation success. It can help to identify similarities among the target groups and establish a comparative level between and among groups (Barlow and Hersen, 1984).

Many tests were applied and some of them were specifically created for the INFOChain experiment (i.e.: Place Cognition Test: City Knowledge and The Risk Perception/Behaviour along the journey). They need to be tested more extensively (amplifying the sample size) in order to be considered valid and reliable. They were used in this study to compose the Individual Capability Provision (the individual cognitive knowledge and affection, respectively) which is one of the inputs used to establish the profile of the Deviation curve.

The procedure to obtain the deviation curve for each participant and for each journey was described. For this conceptual curve, it is assumed that the participant is aware of his/her individual capabilities and is capable of judging the differences between his/her own capabilities and the general environment conditions (his/her deviation) and would develop some strategies to deal with them (for example: select specific information or impose some restrictions on him/herself) to compensate for any deviations.

After understanding the participant's capabilities and the impedances of the environment condition where the activity is developed the next stage is to investigate how the participant is going to use this information to complete the journey. The SCA/CM is presented in the next Chapter, and it helps to explain the individual's adopted decisions and the information requirements for the elaboration of a journey plans and execution of journey in a real environment.

6 INFOCHAIN EXPERIMENT METHODOLOGY – PART B: THE APPLICATION OF SCA/CM

The first part of the methodology was described in Chapter 5, which set out the setting of the experiment: the Battery Test, the Environment Inventory and the construction of the Deviation Curve to characterise the participant and environment aspects of the methodology.

The part of methodology described in this chapter discusses how to capture the participant's use of information in the process of planning and doing a journey by bus (and thus complete the proposed activity). Section 6.1 presents some preliminary considerations introducing the general idea of the single case analysis as the methodology adopted to extract information from the participant. Section 6.2 details the application of SCA/CM to the INFOChain perspective. Each phase of the classical ABA format is described in Subsections 6.2.1 to 6.2.3. The outputs of SCA/CM are then organised to study the participant-environment-activity interactions, the full description of which is presented in Section 6.3. Section 6.4 presents some considerations about the validity and reliability of the experiment and finally Section 6.5 summarises the conclusions of this chapter.

6.1 PRELIMINARY CONSIDERATION

This particular part of the study describes how the participant's information use is going to be captured. The use of public transport information to do a journey by bus into an (un)familiar environment involves not only the investigation of the mechanisms of the plan construction (a problem-solving activity) but also the mechanisms of actions (movements in both imagined and real environments) which are meant to translate the plan into movement in order to arrive at a destination to do an activity. The set of topics that allow basic understanding of 'information use' are defined as Selection of information pieces, the Processing of information pieces to produce usable information and the Use of this information in executing the journey.

- i. Selection of information pieces: what kind of information was selected by participant in order to construct the plan to go from the origin (UCL) to a given destination (the hospital);
- ii. Processing information: the information processed to do a journey in real the environment. It includes investigation about the processing of the selected information and the participant's previous knowledge (in memory);
- iii. Use of information: the information used to do a journey in the real environment (how the journey is executed)

One point should be made clear about the difference between the selection and the processing of information: The INFOChain results demonstrated that not all information that is conveyed by each type of the selected information piece (e.g.: the timetable, the A to Z, the Journey Planner) is processed by the participant and the amount of information transferred to the plan (written and oral version) is less than the participant has actually processed. These points are going to be extensively examined and discussed in Chapter 7, Chapter 8 and Chapter 9.

The aspects concerning each of three steps of information use (select/process/use) are described in Table 6.1. Details about each of the elements of analysis (i to vi) listed in Table 6.1 are given in Section 6.2.1.

Table 6.1 – Capturing the basic understanding of information use

Information Use Step	Definition	What to look for	How to look	How to capture	Elements of Analysis
1. Selection of information pieces	This corresponds to pieces of information selected by participant in order to construct the plan to go from the origin (UCL) to a given destination (the hospital).	What are the elements (information pieces) investigated by the participant and which are finally chosen and represented on the plan.	How the information is organised. Count the number of subtasks within each stage of the journey which are formally represented in the participant's plan document.	i. Observing plan construction. ii. Asking the participant to describe the plan.	i. The plan document and participant's description of the plan.
2. Processing the selected information	This includes the information that is known to participant but was not represented in the plan task.	What are the elements of which the participant is aware but which were not represented on the plan?	How the information is expressed in different forms. Count the number of subtasks in each stage of the journey formally represented in the each test.	Applying the test: i. Bus System Questionnaire ii. Token Manipulation Exercise iii. Representation of Journey	ii. The questionnaire iii. The token picture iv. The representation of the journey document
Pre-Journey processed information	Sum of the consciously known information before the journey: all information (subtasks) represented in the plan and extracted by questions/tasks in each stage of the journey.				
3. Use of information In-Journey information	This corresponds to the way the journey was executed in real environment.	Which elements are actually used in-journey. Movements and actions taken during journey execution.	Describe how the journey was made. Opinions from specialist groups were used to count the number of subtasks along each stage of the journey formally represented on the report.	i. Generate a report of the journey execution. Follow the participant while the journey is executed. Mark movements on a map. Collect the time and position in the journey chain where information was used. Add actions taken by participant. Add emotions states. ii. Ask participant to describe the journey.	v. Interviewer report and participant's oral version of the journey
Post-Journey processed information	This corresponds to the information retained in long term memory that could be transferred to another person.	What are the elements retained after the journey execution	Count the number of subtasks within each stage of the journey formally represented in the each test.	Applying test: i. Representation of Journey in the form of a description of the journey for another person to use	vi. The representation of the journey document.

As explained in Chapters 2 and 5, the format chosen to examine the individual strategies to deal with Public Transport Information (selection/process/use) was Single Case Analysis (SCA). The main reason to choose SCA was the formality and consistency between measures and the flexibility it allows in the construction of the new tests. The traditional format of SCA was adapted to the specificities of this research resulting in the SCA/CM, so that it is possible to incorporate evidence of the interaction between the individual and the environment.

The format adopted in INFOChain was the classical ABA, illustrated in Table 6.2.

The first phase is the Baseline (A) phase which allows deep analysis of the ‘natural way’ a participant plans and executes his/her journey (i.e. how they undertake these tasks without any intervention from the research team). In order to extract this natural way an extensive set of tests was applied using many different approaches to guarantee that the participant was not induced to use information in any specific way: the participant was free to choose content, format and media from the spectrum of information available (provided by public authority or specifically tailored for the journey) and to make any kind of representation (textual, schematic, symbolic or combination of these).

The Baseline phase is followed by a ‘Treatment’ phase (B) in which the participant is made aware of the importance of information and the risk in each stage of the journey chain. Specific emphasis is given to information about accessibility, much of which was produced specifically for the experiment.

The last phase (A) reinstates the opportunity to plan the journey (as in the Baseline phase) but, this time, the participant has become aware of accessible information that could be produced to ‘smooth’ the journey (reduce effort) as a result of the treatment in the Treatment phase. The key aspect to verify is if any modification to the pattern can be observed in relation to the way the plan is constructed, e.g. a different selection of information type, a different organization of information and any differences in the execution of the journey which could be formally attributed to the use of information.

The next section details the full experiment as applied to INFOChain, starting with Table 6.2 which summarises the steps taken in each phase of the experiment. The

following Subsections 6.2.1 to 6.2.3 explain in detail the tests and procedures adopted in each phase (Baseline (A), Treatment (B) and Return to Baseline (A)). Subsection 6.2.4 explains how to analyse the data captured by the experiment and Section 6.2.5 provides some considerations about the validity of the tests.

6.2 INFOCHAIN EXPERIMENT – PART 2: SCA/CM

Table 6.2 illustrates a simplified view of the set of tests applied during the ABA format application.

Table 6.2 - Experiment Phase Description

BASELINE (A)	TREATMENT (B)	BASELINE (A)
<p>Real Journey Exercise (1st Journey)</p> <p>An origin-destination pair is given to the participant who has to plan and do the journey between them.</p> <p><i>(1) Before Journey</i> Structured interview about the plan: assess previous knowledge; ask participant to describe their strategy for doing and evaluating the plan. Apply extra tests to capture the information processed.</p> <ol style="list-style-type: none"> Plan Bus System Questionnaire Token Manipulation Exercise Information Value Representation of Journey <p><i>(2) Journey Execution</i> The Participant executes the journey in the real environment and is followed by interviewer. A report is generated.</p> <p><i>(3) After Journey</i> Back to the origin point (UCL/UnB). Structured Interview about the journey to assess problems and difficulties in the journey.</p> <ol style="list-style-type: none"> Deeper Interview: Assess of Route Knowledge, Distance & Direction Estimation Attention and Anxiety Values Route Knowledge Acquisition Representation of Journey prepared (to inform a 3rd Person about how to do this journey). 	<p>Plan Sensitisation Learning Phase (2nd & 3rd Journeys)</p> <p>An origin-destination pair is given to the participant who has to plan and do the journey between them. The exercise is repeated once.</p> <p><i>(1) Before Journey</i> Structured interview about the plan: assess previous knowledge; ask participant to describe their strategy for doing and evaluating the plan. Apply extra tests to capture the information processed.</p> <ol style="list-style-type: none"> Plan Bus System Questionnaire Information Value Representation of Journey <p><i>(2) Virtual Journey Evaluation</i> The virtual journey is presented to the participant. Evaluation of information value and risk are requested for each stage of the journey chain.</p> <p>Game Phase (4th journey)</p> <p>An origin-destination pair is given to the participant who has to 'buy' the information they think they need in order to plan the journey in a Game-format. Apply extra tests to capture information processed</p> <ol style="list-style-type: none"> Plan Bus System Questionnaire 	<p>Real Journey Exercise (5th Journey)</p> <p>An origin-destination pair is given to the participant who has to plan and do the journey between them.</p> <p><i>(1) Before Journey</i> Structured interview about the plan: assess previous knowledge; ask participant to describe their strategy for doing and evaluating the plan. Apply extra tests to capture the information processed.</p> <ol style="list-style-type: none"> Plan Bus System Questionnaire Token Manipulation Exercise Information Value Representation of Journey <p><i>(2) Journey Execution</i> The participant executes the journey in the real environment and is followed by interviewer. A report is generated</p> <p><i>(3) After Journey</i> Back to the origin point (UCL/UnB). Structured Interview about the journey to assess problems and difficulties in journey.</p> <ol style="list-style-type: none"> Deeper Interview: Assess of Route Knowledge, Distance & Direction Estimation Attention and Anxiety Values Route Knowledge Acquisition Representation of Journey prepared (to inform a 3rd Person about how to do this journey).
Experiment Outputs		
Real Journey (information use in the journey chain before treatment)	Participant's value of information and risks for each stage of the journey chain	Real Journey (information use in the journey chain after treatment)
2 nd day	3 rd day	4 th day

The main contribution of this part of the methodology is the construction of the tests to investigate the use of public transport information - the documental procedures: i.e. the document interventions (the set of information pieces manipulated in relation to (and the procedures associated with) the independent variables) that are functionally related to change in outcomes (dependent variables).

Each phase is detailed in the subsequent sections.

6.2.1 Baseline (A): Real Journey Exercise (J1 and J2)

In this phase, the participant's 'natural way' of planning a journey, without being contaminated by the experiment procedures, was extracted. The participant was asked to plan and do a journey with the origin at UCL/UnB (city centre universities in London and in Brasília) to a specific hospital (details of the location and distance of each journey are presented in Chapter 7 and 8, for London and Brasília, respectively). A structured interview was conducted to extract more data about the 'process of information' (e.g.: information that was selected, processed but not formally represented in the planning phase). Then, the participant was asked to execute the journey in the real environment and return to the origin. When s(he) returned to UCL/UnB a second structured interview was conducted to capture how the information was used in-journey. Contents, objectives and questions/prompts used during the structured interviews are presented in Table 6.3.

A time constraint instruction is applied to the planning task: the appointment time is always fixed 40 minutes after the initiation of the task. The time constraint was introduced based on the principles of Bounded Rationality²⁴ which says that "the information processing differs fundamentally depending on the time available for the task." (*ibid* p: 100) and "The shorter the time available, the more severely the limits imposed by the individual's cognitive architecture influence the subsequent action." (*ibid* p: 57).

²⁴ The Bounded Rationality concept is based on the fact that the rationality of an individual is limited by the information they have, the cognitive limitations of their minds, and the finite amount of time they have to make decisions. Bounded Rationality implies that there are systematic distortions between individuals in information processing (Jones 2001, p: 88).

The intention of the time constraint is to manipulate attention levels and to stimulate impression-based processing which is automatic and driven by the tendency of people not to allocate the time necessary to proceed (as would be the case with memory-based processing, which is a thoughtful process). According to Jones, the time one allocates for a task is the critical determinant of the processing level. The more limited the time available, the more likely the behaviour will fall into a specific cognitive band²⁵. At a cognitive level, behaviour is basically automatic and there is no time to re-evaluate the problem space. In the cognitive band, people make choices on previously formed impressions. They may update their impressions based on incoming information but no time is allocated for rethinking the situation and the problem space is not searched. The idea is that the less one has to search the problem space, the less the demands on attentive capacities and the more the person can devote to more essential goals. With the time restriction, it is expected that it would be possible to identify (1) the most important information chosen during the planning process and (2) the information which arrives during the execution of the journey and which might modify the initial plan as the journey proceeds.

The appointment time is re-evaluated (question 16, Table 6.3) before the execution of the journey in the real environment. The new time fixed by the participant for the appointment is interpreted as an important demonstration of information acquisition and processing because it shows that information has been acquired and processed in a way that enables the participant to consider the likely real performance on the basis of the information (i.e. having looked at the information and thought about it, the journey will take one hour instead of the original estimate of 30 minutes, therefore the appointment time should be half an hour later). The new appointment time is used as the criterion to establish the experimental control for the journey. If the participant arrives at the destination by the time pre-fixed by himself/herself, (s)he succeeds, otherwise s(he) fails. The participant's arrival time at the final destination was evaluated (question # 27, table 6.3) and the subjective participant's evaluation was compared with the real arrival time. Interpretation of the time evaluation is presented in Chapters 7 and 8 for London and Brasilia respectively and summarised in Chapter 9.

²⁵ Cognitive band: refers to the layer of cognition where "the knowledge is brought to bear on a problem, but problem search is constraint" (Jones, 2001, p: 57). Band is a concept coined by Newell (1994) as

In a standard application of SCA, the length of the observation sessions is not specified in advance, and the investigator needs to examine the data and determine if the information is sufficiently clear to make predictions about performance (Kazdin, 1978). After this evaluation the duration can be fixed and usually maintained throughout the experiment. In this study, the length of the observation is determined by participant, with the completion of the task: the plan. The participant's planning time is recorded. The instruction given to compose the plan is that no actual piece of information could be taken on the journey; all the information needed to execute the journey should be transferred to the plan sheet. The length of participant's planning phases was variable and it is presented in Chapters 7 and 8.

As explained in Chapter 2, the number of observations during the Baseline was reduced to one: One single pair of journeys (O/D) to be planned and executed. The reason for this reduction is driven by the characteristic of the behaviour observed: a problem-solving activity that is initiated by demands (the need for the journey) is different from the examples in medical or even educational areas. Any attempt to gather observations about more journeys within the baseline period was considered to risk contamination from the human ability to learn and this would therefore contaminate the understanding of the use of information. This is called the irreversibility characteristic of the human learning process (i.e. it is not possible to 'unlearn' something that has been learnt).

The number of each type (E/T/AI) of information selected (see Table 4.6, Chapter 4) was captured by the unique plan (representation of the journey on a blank sheet using whatever style of expression preferred by the participant, with no suggestion for format). After the planning task, the individual's strategy to plan and to do a single journey was assessed using different types of tests (see Table 6.3).

The tasks are organised in two periods: before- and after-journey assessments. Table 6.3 describes the "Title of the Test Set", the objective for each test and the command used to ask the participant to execute the task. Specific explanations of the Token Manipulation Task, the Bus System Technical Questionnaire and the Landmark Route Allocation tasks are presented in this section.

being the time scale of human action; it is divided in 4 main "bands": social, rational, cognitive and biological.

The extraction of information is intercalated with tests to capture the feelings and individual perception of one's performance and this process is called the metacognition assessment, also illustrated in Table 6.3. Table 6.3 also includes the sources in the literature from which the tasks were derived.

6.2.1.1 Baseline Observations: The Before Journey Assessment Tasks


The first part of the "Selection of Information" tests explores what the participant knows about public transport and about the area in which the journey will be executed. The objective of the first three tests is to check the participant's previous knowledge about:

1. The overall direction of the destination, having UCL/UnB as the origin;
2. The description of alternatives to get to the destination;
3. The participant's knowledge about the destination area.

The fourth test is the plan itself: the document in which the participant synthesises how he/she is going to reach the destination. Current printed information provided by the transport authorities is available to the participant. Access to a computer or to the telephone is also provided for enquiries, but no instruction is given. Thus the participant has to find out the URL address in the case of digital information (e.g.: access to Journey Planner or Street index) and the telephone number (both are printed on the back cover of available information). The list of information available for examination is shown in Table 4.13 (in London), Table 4.15 (in Brasília). The command text is printed on a sheet (See Table 6.3, command # 4) and another blank sheet is given to the participant for them to represent the journey. Neither the framework nor the style of representation is suggested so the participant can represent their plan in any way they choose (e.g. a list of landmarks or a sketch). The plan construction task is completed with an oral interview (command # 5) in which the participant is asked to explain their plan. The oral explanation is important because it can add more information into the plan task (information that is not represented on the paper), while at the same time that it can help the participant to be aware of the quality of his/her plan and help him/her to answer questions 6, 7 and 8 (Metacognition Assessment of Plan).

The next questions in the experiment (9 to 16) are to understand the organization of the selected information (the process of information). Questions 9a and 9b use the “Sentence Frame Technique” by Burroughs and Sadalla (1979) to identify main reference points in a person’s cognitive map. Question 10 was the first attempt to capture the value of information. This question asks the participant to choose the three most important pieces of information to execute a journey by bus. The complete list is illustrated in Table 6.4.

Table 6.3 – The Baseline Phase Set Test

	Title of Set Test	#	Objective/Source Background	Test Commands	
B E F O R E J O U R N E Y A S S E S S M E N T	Selection of Information		Checking previous knowledge (Direction Task: Tversky, 1981 and Kitchin, 1996a)	1. Please mark in the circle the direction of your destination.	
				2. Considering your current knowledge of the transport system, please try to represent possible ways to get to St. Bartholomew Hospital. Please give all the possibilities you know. You can use any mode, even bicycle and private car. Please write everything you can remember in order to get to the hospital.	
				3. Before you start the task, can you please describe how well you know the destination area [0 (not at all) -10 (very well)]?	
		I	Content/Format Plan: Extraction of different types of information (E,T,AI)selection and representation on the formal paper document. (Sketch Maps: Wood and Beck, 1976a, 1989,Galea, 1992)	4. The Plan You are at UCL and you have an appointment at “St Bartholomew Hospital” at []. This appointment is very important for you and you have been waiting for it for 3 months. This hospital is very concerned about time and it takes the appointment-schedule very seriously. Your task is to arrive on time for your appointment but you can only use buses. Some pieces of information are available on request in order to help you plan your journey. You are not allowed to take any printed material on the journey but you can transfer any kind of information you need to the blank sheet. The time is running and you need to come back to this interviewer to acknowledge the time you have returned. A quick interview will be done after you have done the journey.	
			Capture Oral version of plan (Verbal Protocols: Garling <i>et al.</i> ; 1997, Ungar <i>et al.</i> , 1997, Taylor and Tversky, 1992a)	5. Oral Interview: report description of actions, time and type of information used to construct the plan.	
	Metacognition Assessment of Plan Brown (1987), Jacobs & Paris (1987), Garmer (1987) and Schraw & Moshman (1995)		Subjective evaluation of the quality of the plan (before journey)	6. What is your opinion about the plan you just have done? Use a scale from 0 (very poor) to 10 (very good).	
				7. How easy was this task for you? Use a scale from 0 (very easy) to 10 (very difficult).	
				8. What is your level of confidence that you are going to reach your destination-target at the pre-fixed time available for the task? [0 – out of control to 10 – absolutely	

B E F O R E J O U R N E Y A S S E S S M E N T				<i>confident]</i>
	Process of Information		Use of landmarks (Burroughs and Sadalla, 1979)	9a. _____ is close to _____.
				9b. _____ is essentially next to _____.
			Importance of information (before journey)	10. Please choose the three most important information pieces that have or could have helped you to complete the journey plan. A list of information pieces is given in Table 6.4
		II	Token manipulation Whimbey and Lochhead (1986) and Heylighen, (1988).	11. Please put the elements (tokens) in order of how you would search for information to compose your journey. You don't need to reproduce what you have done in your plan. A list of tokens is given in Table 6.5 Now that you have finished your plan, put the elements in order of importance, using a vertical axis to show the relative level of importance [Y].
			Checking knowledge acquisition	12. Please mark in the circle the direction of your destination.
				13. Considering your current knowledge of the transport system, please try to represent possible ways to get to St. Bartholomew Hospital. Please give all the possibilities you know. You can use any mode, even bicycle and private car. Please write everything you can remember in order to get to the hospital.
		III	Representation of knowledge acquired	14. Now that you have planned your journey, please represent it in the space below.
		IV	Contents of knowledge acquired	15. Technical Journey Questionnaire (Table 6.6)
	Metacognition Assesment of Time Restriction		Experiment Control (for Execution of the journey)	16. Now that you know how long this journey will take, what is a reasonable time to suggest for your appointment so that you can guarantee you will arrive on time? Current Time: Time estimated to get to your appointment

A F T E R J O U R N E Y A S S E S S M E N T				
	Use of Information	V	Capture Oral version of the journey	17. Oral Interview: report description of actions, time and type of information used in journey.
			Use of landmarks	18a. _____ is close to _____. 18b. _____ is essentially next to _____.
		VI	Representation of knowledge pos-journey	19. Please do a representation of your journey to give to a third person to do the same journey. Remember, the person is not familiar with the area.
		Check knowledge acquisition (Deeper Interview)	20. The route below represents your journey to the hospital. Please mark on the route the landmarks presented in Figure 1. Now, please add on the same route-map three more references:	
			21. Estimate the distances between (given pairs)	
			22. Finally, plot on circle the direction of St. Bartholomew in relation to UCL (at the centre of the circle)	
		Importance of information (after journey)	23. Now you are going to see the virtual journey of the one you have just made. After analyzing it can you please indicate any piece of information that could be helpful for the other person?	
	Metacognition Assesment of Real Journey Glaser & Chi (1988) and Pressley, Borkowski, & Schneider (1987), Cavanaugh (2000)	Attention level (Sheppard (1964), Jones(2001), Scholl, 2001)	24a. Can you please estimate your level of attention during the different phases of the journey in graphic 1? Consider (0) to be null and (10) to be full attention.	
		Anxiety level (Damasio,1994 and Davidson and Irwin (1999)	24b. Can you please estimate your level of anxiety during different phases of the journey on the graphic 2? Consider (0) to be the less and (10) to be the most anxious.	
		Subjective evaluation of the quality of the plan (after journey)	25. What is your opinion about your plan? Use a scale from 0 (very poor) to 10 (very good).	
			26. How easy was it to complete the journey? Use a scale from 0 (very easy) to 10 very difficult).	
		Subjective evaluation of journey Experiment Control (Subjective assessment of task conclusion.)	27. What can you say about your task to arrive on time for your appointment? [] I have arrived on time, without problems. [] I have arrived on time, despite some problems. [] I missed the time for the appointment, (delay less than 15 minutes). [] I was very late for the appointment, (delay more than 15 minutes).	
28. Based on your impression, please evaluate the journey, giving values from 0 (very easy) to 10 (very difficult) to each phase.				

Table 6.4 – Importance of information

<p><i>10. Please choose the three most important information pieces that have or could have helped you to complete the journey plan. . Please use:</i></p> <p><i>[1] for the most important</i> <i>[2] for the second level of importance</i> <i>[3] for the third level</i></p>
<p><i>[] Pictures of Gaps examples</i> <i>[] Journey Planner</i> <i>[] Travel Information Service (020 7222 1234)</i> <i>[] Area Bus Guide</i> <i>[] London Map – Bus Map & Guide</i> <i>[] Picture Sequence of Landmarks to the Hospital:</i> <i>[] Map of London</i> <i>[] Radial Mobility</i> <i>[] London by Bus</i> <i>[] Picture sequence to bus stop with directions</i> <i>[] Bus Service from Underground Station</i> <i>[] Spider map from “Warren Street”</i> <i>[] Complete drawing map: origin to bus stop at origin area</i> <i>[] Description of path to the bus stop including accessibility issues</i> <i>[] Timetable</i> <i>[] Macro reference map</i> <i>[] A to Z</i> <i>[] Continuing tour journey from ... :</i> <i>[] Pictures and Information of bus stop area</i> <i>[] Accessibility evaluation of bus stop platform</i> <i>[] Route sketch with landmarks</i> <i>[] Drawing Sequence of the path to bus stop</i> <i>[] Bus Stop Sign</i> <i>[] Hospital’s Website</i> <i>[] Location of the nearest adequate access bus stop to get on</i> <i>[] Type of Vehicle</i> <i>[] Fare Costs (Journey Planner)</i> <i>[] Local Public Transport Map</i> <i>[] Duration of journey inside vehicle (Journey Planner)</i> <i>[] Street Map Website</i></p>

Note: Items were randomly listed for different journeys tests and different participants.

An equivalent version was printed for Brasilia’s case.

The next task is the token manipulation.

The Token Manipulation Test was created specifically for this experiment. It was based on the principles of problem solving strategies where the initial goal and the desired goal are presented (Heylighen, 1988). The task is to get from the initial state (origin: UCL/UnB) to the goal state (the hospital) doing a series of actions which are represented by legal operators (things allowed to do in solving problem) and operators restrictions (factors that constraint the application of operators) The aim of the test is to capture the strategy (the type of tokens chosen and their importance) that each participant uses to achieve the target goal.

The test has a defined protocol, described in 8 steps to be followed with the help of Table 6.5:

1. The first two tokens are presented to the participant: origin and destination linked by a black line-base, see Figure 6.1.
2. The other tokens are presented and their content (what they represent) are discussed with the participant, see Table 6.5.
3. The participant is asked to construct the journey again, but this time s(he) is asked to “think aloud”. He/she needs to use the tokens to have access to information.
4. The participant is informed that the types of information available in this exercise are the same as that used when they composed the plan.

The Participant is informed that they are allowed to ask for more information if they realize that they need any other source, even if they have not used it during the planning task.

All the information is available on a table next to the participant.

The final disposition of the set of tokens is captured using a digital camera, Figure 6.1 illustrates one output-example.



Figure 6.1- Example of Token Manipulation Output

Then the participant is asked to re-order the tokens on XY axes according to the level of importance.

5. When finished, the participant is asked to put the elements in a order of importance. (Figure 6.2, Table 6.5)
6. The participant is informed that he/she can change the order, before the end of the task
7. The order of information importance is annotated by the interviewer.





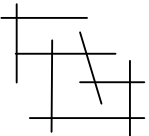







Although it is a new test and many more application are needed to evaluate its validity and reliability, its acceptance was high (100% of participant) and all participants have engaged and finished the task using more the concrete tokens (the legal operators, e.g.: hospital, bus, bus-stop) and less the abstract tokens (the operators restrictions, e.g.: time and cost considerations; in this exercise, mainly time). One particular aspect needs to be mentioned: although the notion of legal operators (to what the participant was allowed access) and constraints (time and cost) were presented, no formal nominations were introduced to the participants. Different applications of the same test, exploring the informal and formal explanation of the tokens' functions might be useful to investigate the effect of concrete and abstract tokens as well as the effect of the constraint's formalization might cause on the individual's strategy.

Another element that can be explored in the observation of an individual's strategy is the evaluator. Evaluators are stages of a strategy where a participant needs to make a decision (represented by the balance token). Evaluation means to analyse possibilities, conveniences and necessity of the journey. In the INFOChain application, the evaluator token was never used without being prompted. After completing the exercise, the participant was asked to add the balance token where a decision would be taken.

In order to explore evaluators, a more detailed application of the test is needed. For this purpose a detail 'State Space Analysis' (Hollenstein and Lewis 2006) should be developed: a diagram considering the complete set of information about everything a solver could do, using only the rules of the problem.

Table 6.5 – Token manipulation test

Here there are elements to help you to compose a journey by bus.

	UCL (Origin Sign)	
	Hospital (Destination Sign)	
	General Direction	Need for general orientation: North, South, West, East
	Specific Direction	Need for specific direction is identified
	Specific Path	Need for specific path detail is identified
	Decision Point	Token used to represent a decision point along the journey chain.
	Time Consideration	<input type="checkbox"/> Frequency <input type="checkbox"/> Waiting time <input type="checkbox"/> Riding Time <input type="checkbox"/> Other expressed by participant
	Cost Consideration	Need to think about money.
	Gap Information	<input type="checkbox"/> How near the driver would park? <input type="checkbox"/> How is the layout of bus stop? <input type="checkbox"/> Other expressed by participant
	Bus Stop Information	<input type="checkbox"/> Layout <input type="checkbox"/> Information Available <input type="checkbox"/> Shelter and seats <input type="checkbox"/> Countdown
	Landmark Reference	Need to have a landmark reference
	Walking Environment Information	<input type="checkbox"/> Safety Level <input type="checkbox"/> Light Conditions <input type="checkbox"/> Footway width <input type="checkbox"/> Footway Crossfall <input type="checkbox"/> Other expressed by participant

11. Please put the elements (tokens) in order of how you would search for information to compose your journey. You don't need to reproduce what you have done in your plan. A list of tokens is given in Table 6.5

Now that you have finished your plan, put the elements in order of importance, using a vertical axis to show the relative level of importance [Y].

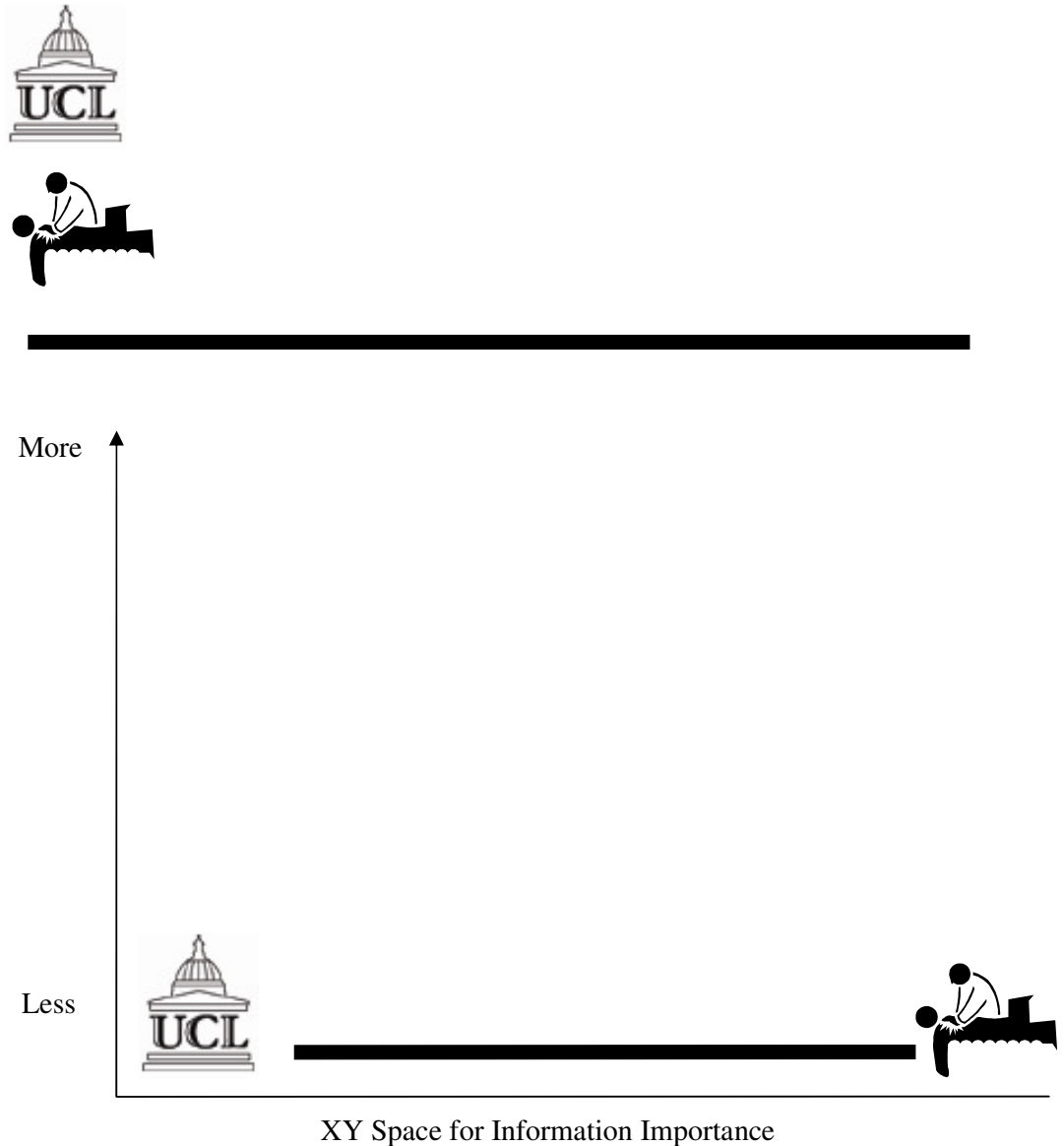


Figure 6.2 – Token Manipulation Test

The next step of the investigation of the organization of information is to verify if there was actually any kind of information acquisition. Questions 12, 13 and 14 ask to repeat procedures already done: distance and direction between origin and destination; possible ways to execute the journey using public transport and representation of the journey after having access to information.

Question 15 is a technical questionnaire (Table 6.6) to capture knowledge specifically related to the bus system content. There are 9 questions about all the stages of a journey by bus.

Table 6.6 - Technical Questionnaire Test

Questions	Answers
<i>1. How will you get to the bus stop at origin?</i>	
<i>2. Number of the bus to take?</i>	
<i>3. When you got to the bus stop, what is the next time departure of your bus service?</i>	
<i>4. What is the frequency of the bus service you have chosen?</i>	
<i>5. Duration of the trip by bus</i>	
<i>6. Where to get off:</i> <i>6.1. How will you know when to stop?</i> <i>6.2. What kind of mark you have chosen:</i> <input type="checkbox"/> <i>Landmark (which one?)</i> <input type="checkbox"/> <i>Ask driver (what question?)</i> <input type="checkbox"/> <i>Ask passengers (what question?)</i>	
<i>7. How will get to the final destination?</i>	
<i>8. Duration of the journey</i>	
<i>9. Cost of the journey</i>	

The last question of the Processed Information set (# 16) that is completed before actually doing a journey, was the re-evaluation of time. The current time is checked and the participant is asked to say what time it would be reasonable for him/her to arrive at the destination if s(he) were to leave now, given that he/she has already done the planning and thought a lot about the specific journey. The time of arrival at the destination point, estimated by the participant, is very important and it constitutes the objective attribute that will define the success of the journey. If the participant reaches the destination at the predicted time the journey is considered done. If not, the participant would have failed to complete the task imposed by this experiment. The subjective evaluation of each journey by each participant is presented in Chapters 7, 8 and 9.

6.2.1.2 Baseline Observations: The Journey Observations

After question number 16, the journey is initiated. Carrying only the plan as they have recorded it on the plan sheet, the participant sets off on the journey. They are discreetly followed by the interviewer, who registers the general environment conditions of the

day (e.g.: time, temperature, light condition, rain), assesses the general participant physical condition (e.g.: how they feel (any tiredness), if they have any problem that could disturb the execution of the journey they are about to begin (e.g.: pain, shoes, rain)), marks the path/route onto a schematic city map, registers any interaction made with a third person, and registers the time at which each stage of the journey was completed. An interviewer report is generated.

This method does not capture how the environment cues were absorbed by participant (which is of course an internal information process), neither does it reliably capture what the participant is looking at (or oriented his attention to), nor can it explain how the aspects of the physical environment (e.g.: temperature, lighting, humidity, ambient noise and unshielded electrical sources) might affect the participant's response (as suggested by Haynes and Wilson (1979) and Ray *et al.* (1979)). However, it does describe the actions taken by participant in order to complete each stage of the journey, and these described actions are considered to be the outputs of the interaction with the environment. A report is generated and used to identify the individual coping strategies in the real environment, supported by Kitchin and Tate (1999) who emphasised that rather than identifying patterns, the researcher attempts to interpret the data: "The core interpretative qualitative analysis consists of describing data, classifying data, and finding out how concepts interconnect" (Kitchin and Blades, p: 158)

The interviewer report was individually evaluated by specialists in transport (Transport MSc and PhD students), who judged the evidence (presence/absence) of subtasks for each stage reported in each city case. Five specialists were used in London and seven in Brasilia. Each specialist extracts which attributes (from the 40, Table 4.8) are present in the report for each journey stage, giving a scale value from 0 (not present) to 1 (fully present). A minimum number of specialists had to agree (3 in the London case and 5 in the Brasilia case) to accept the valid presence of a subtask.

In relation to the reaction to the 'observer effect', the observer was instructed to behave in a discreet manner, maintaining a distance of about 2m and with no interaction. There is also evidence in the literature (Trochin, 1982) that, as time goes on, the participant is likely to become accustomed to the observer's presence and acts normally. It is recommended (Barlow and Hersen, 1984) that in order to obtain reliability, behaviours must be observed many times. Although in this particular study 'many times' was

reduced to three days, the participants were observed for long periods. The pilot studies showed that because participants had a real target (a long-awaited appointment at the hospital) they focused on the task and continually applied efforts to get to the destination by the time previously estimated by them and they tended to ignore the observer.

In relation to the use of a camera, it was initially considered to record the movement, and to use computer programs to count some pre-defined occurrence of events, but the evaluation of this data still relies on an act of laborious and manual interpretation. The use of infrared beams coupled to electronic counters was not considered, in this research, not only due to the early stage of technology but also because it would eliminate an important part of the experiment output: observation of participant's interaction with environment. Particularly in the interest of this research, the potential use of eye tracking image technology²⁶ (focus on what the participant is paying attention to) was not completely consolidated yet (e.g. there were problems with sunlight reflections).

The application of virtual environment designs was also not considered in this study because the investigation of the planning of a journey "*per se*" involves a great amount of mental processing and its use can only be validated with the exposure to the real environment. Another issue is that the study in question deals with the open environment and physical displacement inside a bus.

Therefore, for the purpose of this research, observation of the pedestrian movement were conducted by a following observer who was instructed to keep a distance, not interact with participants, and register the path on a map and any formal oral request to gather information. All participants agreed and no major objections were registered. Subjective evaluations of the participant's behaviours can also be added by the interviewer if necessary. The subjective evaluation, e.g.: alteration of the participant's physical appearance or moving pattern (from walking to running) or the alteration of the participant's emotional state (e.g.: agitation, nervousness) was used as form of assessment due to the technical difficulties of doing this in the public transport environment (i.e.: resources, protocol procedures and ethical permissions) involved in

²⁶ Eye tracking is the process of measuring either the point of gaze ("where one is looking") or the motion of an eye relative to the head. (Duchowski, 2003)

using methods such as skin impedance or heart rate monitors to assess physical and emotional alterations (stress and anxiety) (Malmivuo and Plonsey (1995), Storm *et al.* (2005) and Strauss *et al.* (2005)).





6.2.1.3 Baseline Observations: The After Journey Assessment Tasks

After the journey, the participant returns to UCL/UnB and the after-journey assessment begins. This assessment has two main parts: questions about the journey itself and questions about the participant's feelings during the journey. Table 6.3 illustrates the main purpose of the test and the commands used.

The after-journey-phase of the experiment starts with an open interview in which participant is asked to describe the journey in words. The interview also checks if the participant can identify any fault in their plan, such as any unanticipated obstacle, any reaction to unexpected situations (e.g.: deviation, assault) or any important landmark reference. This oral description of the journey is added to the interviewer report output and analysed by the transport specialists.

Questions 17 to 28 are created to check the use of information. Question number 18a and 18b repeat question number 9a and 9b and deal with the use of landmark. This captures alterations in the pattern of answers. Question 19 asks the participant to represent the journey in order to give directions to a third person, again on a blank sheet, without pre-format. Questions 20, 21 and 22 check knowledge acquisition. Question 20 deals with landmark allocation on the route, as illustrated in Figure 6.3. Question 21 deals with distance assessment and question 22, with direction.

20. The route below represents your journey to the hospital. Please, mark on the route the landmarks presented in Figure 1.

			
Building over Procter Street (B)	St. Paul's Cathedral (PC)	Holborn Viaduct (HV)	Sicilian Avenue (SA)

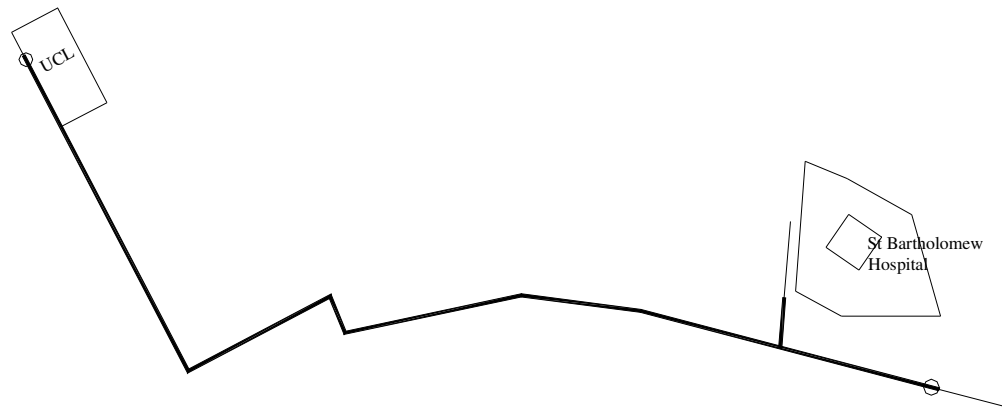


Figure 1: Schematic route UCL to St Bartholomew Hospital

Now, please add on the same route-map three more references: Holborn Station (HS) Chancery Lane Station (CLS), Old Barley (OB).

Figure 6.3 - Route Allocation Test

Question 23 introduces the concept of a virtual journey. A virtual journey consists of a detailed textual description and pictures about different features of each stage of the executed journey. The full-virtual-journey stages are presented to the participant who has to select any type of information that would be helpful for a third person to do the same journey.

Feelings are treated in Questions 24a and 24b: Attention and Anxiety are extracted using a subjective numerical scale from 0 to 10 for each stage of the journey chain, as illustrated in Figure 6.4. No objective indicators were captured in this task.

24a/b. Can you please estimate your level of attention/anxiety during different phases of the journey on the graphic 2? Consider (0) to be the less and (10) to be the most level of attention.

Can you please estimate your level of **attention** during different phases of the journey on the graphic 1? Consider (0) to be null and (10) to be full attention.

(Full) 10							
9							
8							
7							
6							
5							
4							
3							
2							
1							
(Null) 0							
	Plan	Walk to Bus Stop	Wait at Bus Stop	Get on Bus	Ride	Get off Bus	Walk to Hospital

Figure 6.4 –Attention/Anxiety Test

Finally, questions 25 to 28 ask about the participant's subjective evaluation of the journey execution. Question 28 captures an individual global assessment about his/her own performance.

This is the complete Baseline Test Set and it represents the first contact that participant has with the experimental procedures for planning and execution of a journey by bus. It is considered to be the purest answer the interviewer can obtain from the participant and therefore the closest form to the participant's natural way of doing a journey.

The objective questions are converted into numerical values. The subjective questions are compared between period of assessment (before and after journey). More detail is given in Section 6.3. Results and interpretations are given in Chapters 7 and 8.

The next phase of the experiment is the Treatment Phase (B), the intervention in which the independent variables, the information pieces are actively manipulated. The

treatment was tailored to sensitise the participant towards barriers and obstacles that could be found during the journey. It is constructed in order to make the participant think about the importance of the information given and the value it might have for the participant. Information was created for the experiment and it reflects the accessibility issues raised in Chapters 2 and 4.

6.2.2 Treatment (B): Virtual Journey exercises (T1, T2 and T3)

The treatment phase starts with a sensitization exercise. The objective of the sensitisation exercise is to introduce a spatial schema to help the organization of different information in a sequence, which represents the flow of information throughout the journey – i.e. the Information Chain along the Journey Chain.

In theory, the schema (Neisser, 1976) would help individuals to concentrate on information that was important for his/her personal profile and to inhibit the information that is not suitable for their needs. The sensitization also serves at a very basic level to even the initial concept of the journey chain among participants and to emphasise the importance of each stage that comprises the journey. Figure 6.5 illustrates the INFOChain visual schema used for this process. The visual spatial schema can also function as a mechanism to retrieve memories.

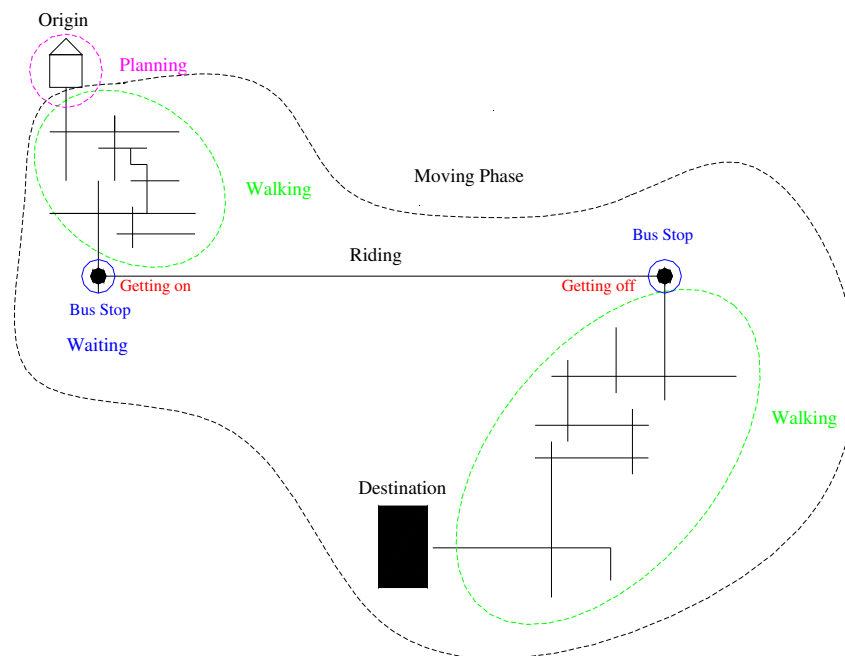


Figure 6.5 – INFOChain Visual schema of a Journey Chain

6.2.2.1 The Sensitization Exercise

After the presentation of a general journey schema a training assessment exercise is applied and the accessibility issues discussed with the participant. In this exercise, many pictures of real situations are shown to the participant exploring the difficulties that could be found in each stage of a journey chain. Examples of accessible information (pictures) to deal with the difficulties in each stage are also introduced to the participant. Some examples are illustrated in Annex 1A (London) and 1B (Brasília). The objective was to prepare the participant to evaluate the journey stage by stage. The analysis of virtual journeys T1 and T2 (the Treatment phase) begins after the training.

6.2.2.2 The Virtual Journey Analysis

Participants are asked to plan two more journeys to different hospitals, using the same commands applied in Baseline (A), Journey 1. The origin and the destination points are given. The same set of tests presented in Table 6.3 (the Before Journey assessment) is applied. The execution of the journey is changed into the analysis of the virtual journey.

The virtual journey consists of a set of pictures, drawings and text descriptions for each stage of the journey chain (Walking to the bus stop, Waiting at bus stop, Getting on the bus, Riding, Getting off the bus and Walking to final destination). The objective of the presentation of virtual journeys exploring accessibility issues is to sensitise individuals to hazards they could find along specific journeys. It also provides a diagnosis of specific accessibility conditions for each stage, e.g.: footways maintenance; traffic flow; pedestrian flow; crossing points; bus stop area; vertical and horizontal gaps and vehicle conditions. Some examples of the information provided to the participant are presented in Tables 6.7 (a, b, c) and Figure 6.6.

Table 6.7(a) – Example of Virtual Journey Walking Stage: UCL to Royal Free Hospital

You will need to take your bus (24) at Warren Street Station (X). To walk from UCL to Tottenham Court Road, where the target bus stop is located, some streets will need to be crossed. Table 1 illustrates the sequence of crossing points and the environment. Walking from UCL, turn right and cross Gower Street, which is formally signalled with a pedestrian call button but there is time pressure to cross the road. The traffic flow is very heavy on Gower Street. Walking down Grafton Way, cross Huntley Street in front of UCL hospital, which is two-way street but with no traffic signal, although the traffic is low. Still in Grafton Way, walk down to the corner with Tottenham Court Road. To cross Grafton Way there is a formalised crossing with a pedestrian button. Tottenham Court Road is a large street with a pedestrian island in the middle and intense traffic flow. The pedestrian flow is also very intense.

This last crossing requires particular attention to the turning movements. Check the direction of the cars because they come from both Grafton Way and from Tottenham Court Road. The crossing needs to be done in two stages. The bus stop (X) is just further down. Pictures and drawings illustrate the crossing sequence.

Table 6.7(b) - Crossing points: Picture Sequence

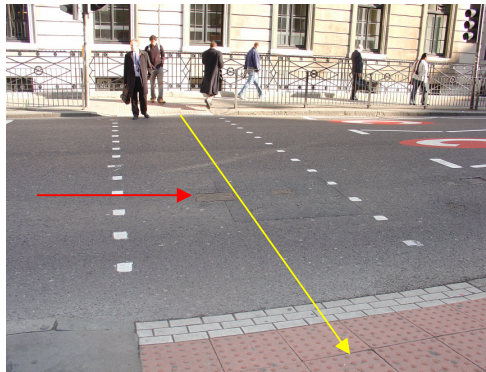


Figure 1 – Crossing 1: in front of UCL



Figure 2 – Crossing 2: in front of UCL Hospital



Figure 3 – Crossing 3: Grafton Way



Figure 4 – Crossing 4: Tottenham Court Road

Continuing Table 6.7(b) - Crossing points: Picture Sequence

The area is characterised as a commercial one. The total walking distance is 300.7 m or 4 minutes. The pavers are in reasonable condition and all crossfalls are under 2.5%.

Red arrows represent vehicle movements and yellow arrows, the direction that pedestrians need to take to get to the bus stop

Table 2 represents schematic graphics of the crossing sequence. Red arrows represent vehicle movements and blue arrows the pedestrians' direction to get to the bus stop (X).

Table 6.7(c) Crossing points: Drawing sequence

<p><i>Graphic 1 - Crossing Point 1: in front of UCL</i></p>	<p><i>Graphic 2 - Crossing Point 2: in front of UCL Hospital</i></p>
<p><i>Graphic 3 – Crossing point 3 and 4</i></p>	

Graphic 4 illustrates the complete path from UCL to Bus Stop (X) at Tottenham Court Road.

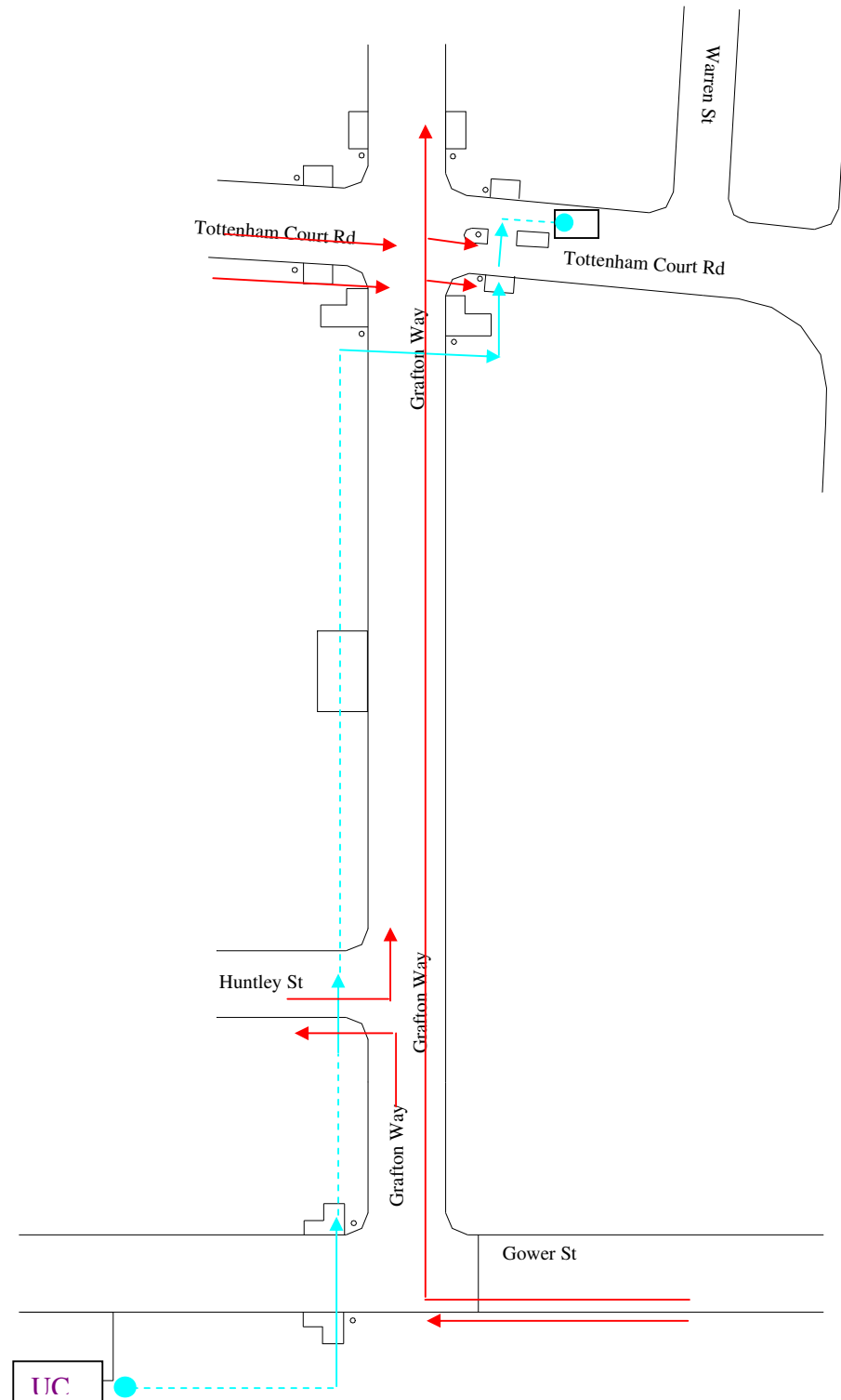


Figure 6.6 – Path from UCL to Bus Stop X at Tottenham Court Road

After each virtual presentation of each stage, the values of information are evaluated according to a numerical scale [0-10]. Table 6.7(d) (participant's answer sheet)

illustrates an example (the ‘walking’ stage). The potential risk at each stage is explored and then evaluated. The important outputs of this phase of the experiment are the relationships between difficulties, the value of information and perception of risk (and risk behaviour) in each stage of the journey chain.

Table 6.7(d) – Participant’s answer sheet for (‘walking’ stage example)

<p><i>Now considering what was exposed:</i></p> <p>a) <i>How easy is to walk to the bus stop? Use a scale from zero (very easy) to 10 (very difficult).</i></p>																																
0	1	2	3	4	5	6	7	8	9	10																						
<p><i>very easy</i> <i>very difficult</i></p>																																
<p>b) <i>Which is the most important piece of information given? (Chose only one)</i></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td><input type="checkbox"/></td><td><i>Landmarks Pictures</i></td></tr> <tr><td><input type="checkbox"/></td><td><i>Walking distances</i></td></tr> <tr><td><input type="checkbox"/></td><td><i>Crossfalls (footways inclination)</i></td></tr> <tr><td><input type="checkbox"/></td><td><i>Traffic flow features</i></td></tr> <tr><td><input type="checkbox"/></td><td><i>General text description of the area</i></td></tr> <tr><td><input type="checkbox"/></td><td><i>Pavers conditions</i></td></tr> <tr><td><input type="checkbox"/></td><td><i>Pedestrian flow features</i></td></tr> <tr><td><input type="checkbox"/></td><td><i>Crossing drawings (individually)</i></td></tr> <tr><td><input type="checkbox"/></td><td><i>Path to the Bus Stop (complete drawing)</i></td></tr> <tr><td><input type="checkbox"/></td><td><i>Crossing Pictures (sequence)</i></td></tr> <tr><td><input type="checkbox"/></td><td></td></tr> </table>											<input type="checkbox"/>	<i>Landmarks Pictures</i>	<input type="checkbox"/>	<i>Walking distances</i>	<input type="checkbox"/>	<i>Crossfalls (footways inclination)</i>	<input type="checkbox"/>	<i>Traffic flow features</i>	<input type="checkbox"/>	<i>General text description of the area</i>	<input type="checkbox"/>	<i>Pavers conditions</i>	<input type="checkbox"/>	<i>Pedestrian flow features</i>	<input type="checkbox"/>	<i>Crossing drawings (individually)</i>	<input type="checkbox"/>	<i>Path to the Bus Stop (complete drawing)</i>	<input type="checkbox"/>	<i>Crossing Pictures (sequence)</i>	<input type="checkbox"/>	
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<input type="checkbox"/>	<i>Crossing Pictures (sequence)</i>																															
<input type="checkbox"/>																																
<p>c) <i>How useful is this piece of information? Use a scale from zero (useless) to 10 (very useful).</i></p>																																
0	1	2	3	4	5	6	7	8	9	10																						
<p><i>useless</i> <i>very useful</i></p>																																
<p>d) <i>Which are the potentially risky situations you can imagine at this stage of the journey? Evaluate the risk [0 (No Risk) to 10 (Very Risky)]</i></p>																																
<p>e) <i>Which are the pieces of information that might help to attenuate the risky situation(s) described?</i></p>																																
<p>f) <i>Will you consider taking the potential risk to complete the journey?</i></p>																																

Similar information and tests are then undertaken for each stage of the journey.

A second origin-destination pair is given (T2) and the whole exercise is repeated. The level of difficulty of the journeys is increased gradually during the experiment. It is expected that the quality of the journey plan as well as the number of correct answers on the technical questionnaire of bus system assessment would also increase during the experiment because it is expected that the participant would become more familiar with


information and thus pay more attention to important issues that could be extracted from each information piece in order to reduce their effort during the moving phase of the journey.

Observations are made during the application of the treatment to determine if the individual accepts the visual schema with any representation of it in his/her subsequent plan. The important point is to verify if there is any formal identification of the stages or the selection of information which covers the stages within the journey chain.

The next journey (T3) uses a different process to establish the relative importance of different elements of the set of information pieces as far as the participant is concerned. This is achieved by means of a simple game.

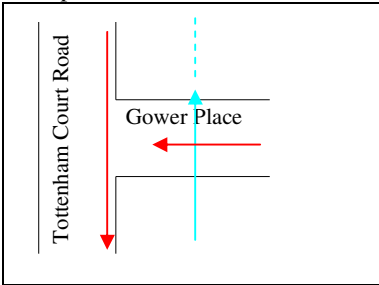

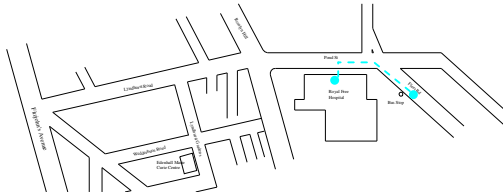
6.2.2.3 The Game Application in the Treatment Phase (T3)

In the Game phase, participant can 'buy' (instead of just select) the information he/she needs to plan the journey. The information is presented in 3 different levels - Available Information; Special Information and Customised Information – as illustrated in Table 6.8 for the walking stage of the journey.

Available information is the current information provided by the local authority and public transport operators. Special information is information which details physical aspects of the specific environment(s) involved by each stage. Customised information focuses on the accessibility conditions of each stage. Each piece of information has a price represented by a token .

The participant is free to buy information from any level. The time for the inspection of the information is limited to 3 minutes to examine all the information pieces, after which he or she may request the amount of tokens to buy the information s(he) has chosen. A monetary restriction is also imposed (the general rule is to give half the number of tokens requested). The restrictions are imposed following the principles of Bounded Rationality (Jones 2001) so that restrictions lead the participant to work in the cognitive band, only choosing/buying the most important information for the journey chain.

Table 6.8 – The Game Procedure: Example of the Walking to Bus Stop stage

Level 1 – Available Information	Level 2 – Special Information: Drawing sequence of path to the bus stop	Level 3 – Customised Information: Accessibility Guide: Path to the Bus Stop (pictures and comments)																				
<div>A to Z access</div> <div>1T</div> <div>Journey Planner Access</div> <div>1T</div> <div>1T</div>	<div>Drawing sequence of the path to bus stop</div> <div>1T</div> <div>Example:</div> <div></div>	<div>Picture sequence to bus stop with directions</div> <div>1T</div> <div>Example:</div> <div></div> <div>Figure 1 – Along Gower Street No signal</div>																				
Additional Information																						
<div>Bus Service from Warren Street</div> <div>1T</div> <div>Spider map from Warren Street</div> <div>1T</div>	<div>Complete Drawing Map: Origin to Bus stop at origin area</div> <div>1T</div> <div>1T</div> <div></div>	<div>Description of path to the bus stop including accessibility issues</div> <div><table><tr><td colspan="2">Accessibility Guide Contents</td><td>1T</td><td>1T</td></tr><tr><td>Number of streets to cross</td><td colspan="3">Type of street</td></tr><tr><td>Footways conditions</td><td colspan="3">Footways Crossfalls</td></tr><tr><td>Traffic conditions</td><td colspan="3">Pedestrian Flow</td></tr><tr><td>Physical barriers</td><td colspan="3">Distance in metres</td></tr></table></div>	Accessibility Guide Contents		1T	1T	Number of streets to cross	Type of street			Footways conditions	Footways Crossfalls			Traffic conditions	Pedestrian Flow			Physical barriers	Distance in metres		
Accessibility Guide Contents		1T	1T																			
Number of streets to cross	Type of street																					
Footways conditions	Footways Crossfalls																					
Traffic conditions	Pedestrian Flow																					
Physical barriers	Distance in metres																					

The participant is then asked to represent the plan of the journey on a sheet of paper, as they had for the previous journeys. The same approach is used (questions 1 to 15, Before Journey assessment, in Table 6.3)

The questions applied during treatment support subjective features of the journey, such as risk, declared knowledge of the area, anxiety and attention. More descriptions are given in Section 6.2.4 and results and interpretations can be found in Chapters 7 and 8.

6.2.3 Return to Baseline (A)

The last phase of the experiment – return to baseline condition – is set as another real journey exercise. The participant is asked to do another similar journey from the same origin but to a different destination in the real environment.

This time the objective is to capture and compare the quality of the planning phase and the journey itself with the first real journey exercise. The same types of questions/tasks are applied in the before- and after-journey assessments.

The expectation is that, at the end of the experiment, the individual will have selected not only the information that would guarantee his/her displacement to the final destination (e.g. complete and adequate information about the bus service) but also the information that can smooth the journey problems (e.g. information about barriers) according to his/her own capability (e.g. physical and emotional).

6.2.4 How to employ the data captured in INFOChain Experiment?

As explained before in previous sections (see Table 6.1), there are 6 important elements of analysis in each real journey (J1 and J2) grouped as selected (item (i) below), processed (items ii to iv) and used (item v). Item (vi) is used to complement the individual analysis.

- i. The plan document and participant's oral description of the plan.
- ii. The Bys System Technical Questionnaire.
- iii. The Token Picture.

- iv. The representation of the journey document before execution of the real journey.
- v. The Interviewer Report of the Journey and participant's oral description of the journey.
- vi. The representation of the journey document after execution of the real journey.



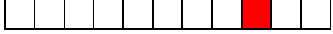



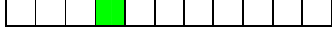






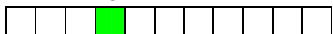






All the previous outputs (i to vi) are scrutinised under the subtasks classification for each stage of the journey (Table 4.6, Chapter 4). The first task is to investigate if the subtask is present in the element of analysis. For example, in the plan document analysis, any reference/evidence (e.g. drawing, text, oral expression, token identification) of the first subtask of the first stage (e.g.: path identification information during the walking stage to bus stop) is sought. Then a judgement is made about how much of the subtask is represented in the document of analysis. The value can vary from [0, 1]. Each subtask for each stage of the journeys is checked in this way. The values are then added for each stage of the journey and plotted on a radar diagram in which the axes represent the dimensions of the journey. (Example radar plots are illustrated in Figures 6.8 and 6.9). The area inside the curve represents how much of the journey is covered by the each element of analysis applied in each phase of assessment (before-, in-journey and after-journey). The interpretation of these plots for the experiments is given in chapters 7 and 8.

The subjective data extracted are the metacognition assessments ((personal knowledge (questions 2, 3 and 13), subjective impressions of performance (questions 6, 7, 8, 25, 26, 27 and 28), importance of information (questions 10 and 23) and subjective assessments of attention and awareness (questions 24 (a) and (b))). These are used to support the interpretation analysis of the participant's choice about the journey. The objective measures (estimation of distance, time, direction and landmark allocations (questions 1, 2, 9, 12, 16, 18, 20, 21 and 22) are used to evaluate the acquisition of knowledge along the experiment.

For the analysis of the virtual journeys (T1 and T2) conducted during the treatment phase of the SCA/CM application, only items i (plan), ii (Bus System Questionnaire), iii (Information Value) and iv (Representation of Journey) are extracted, given that the execution of the real journey is replaced by the virtual journey. In T3 only items i (plan) and ii (Bus System Questionnaire) are applied, with the information values being determined through the use of the monetary tokens.

In the treatment phase, the emphasis during the analysis of the virtual journey is on the information value and risk assessment. The type of qualitative data extracted is illustrated in Table 6.9 and this is also used to support the interpretation analysis of the participant's choices during the experiment.

Table 6.9 - Example of a typical participant's output for the evaluation of a treatment journey

Stage	How easy is to Very Easy	Very difficult	Information (most important)	How useful is the information Useless	Very useful	Risk	Measure of Risk No Risk	High Risk
Planning	7 		Journey planner Duration of Time					
Walking	3 		Complete path drawing to bus stop	8 		Traffic	8 	
Waiting	0 		Route (schematic)	10 		Traffic accident	3 	
Getting on	2 		Nearest accessible bus stop indication	8 		-	0 	
Riding	1 		Route with landmarks	8 		Traffic hold up Missing destination stop	6  3 	
Getting off	1 		Nearest accessible bus stop indication	7 		Get off at wrong stop	3 	
Walking	3 		Sequence of pictures of the path to final destination	9 		Steepness at Pond St	4 	

6.2.5 Validity and Reliability of the tests

Direct observation of the participant, according to Kitchin and Tate (1999), while s(he) is planning and executing a journey by bus provides a degree of validity as it concentrates on what the participant does as opposed to what s(he) says that they would do. In other words, instead of asking people about the value of information, the experiment actually extracts the value by observing the participant using information in a problem-solving task and real journey exercise.

Limitations of this approach are generally about the observer impact on the participant's behaviour (Section 6.2.1.2) In order to minimise this kind of impact a structured approach using pre-determined categories for recording the observations is adopted. The main advantage of this is that it is fast and efficient and it minimises recording error and interpretation bias.

The categorised structured approach is interleaved with some informal interviews to discuss the quality of the plan and performance after the real exercises in order to understand the problems of the task (doing a journey by bus) from the participant's point of view. Before and after journey open interviews are considered to be extremely useful to validate not only the methodology but also the reliability of the risk assessment phase.

Another action taken to reduce bias is to ask the same question in different ways, for example: the participant is asked to write the plan of the journey; describe the plan in words; represent their journey and so on. The use of some specific terms, such as: 'draw your journey' and 'sketch your journey' is also avoided in favour of a broader phraseology such as 'provide a representation of your journey'.

In relation to the objective measures used in this experiment Kitchin and Blades (2002, p: 130) emphasise that "there has been little research into the validity of distance measures, no research into the reliability of these measures and there is little evidence about how the same person would carry out the same estimation task at different times." The same comment about validity and reliability can be applied to direction tasks. "The only study of the validity of direction-giving tasks (Montello *et al.*, 1999, apud Kitchin and Blades 2002, p: 135) found that participants' performance differed depending on

whether they were asked to make direction estimates by turning their body, or by pointing with a dial.”

6.3 EXPECTED OUTPUTS

From the tests described in Section 6.2.1, 6.2.2 and 6.2.3 it is expected that it should be possible to capture each type of information (E/T/AI) selected to construct the plan and to draw the curves which represent the participant’s use of information (selection, processing and use) for a specific journey.

Figure 6.7 illustrates the traditional measures collected for one participant: the number of information types (E/T/AI) selected and formally represented in the plan exercise during the three phases of the experiment (Baseline, Treatment, Return to Baseline). This consists of the aggregated results of the plan exercise: the ‘Pure (E/T/AI)’ curve represents the total number of information types (which is related to the subtask) formally represented in the plan exercise. The ‘Pot (E/T/AI)’ curve shows the potential essential information and represents the total amount of information (subtasks) that could have been spotted with the information piece(s) selected. Thus ‘E’ ‘T’ and ‘AI’ indicates what is formally represented by the participant in the plan and ‘Pot (E)’, ‘Pot T’ and Pot ‘AI’ indicates what is offered by the information pieces selected.

Figure 6.7 needs to be followed with the actual selection of information pieces, illustrated in Table 6.10). Together they illustrate that the choice of information has not varied in terms of content [Pot (E/T/AI)] although different pieces of information had been selected to compose the plan. The formal representation of the selected information for the plan (E/T/AI, the information extracted and represented in the plan document) is numerically less than the number of information pieces on offer and varies throughout the experiment. The **T-type** of information has become constantly more important for this participant and this could be explained by the time constraint impacts imposed by the experiment. No evidence of the importance of **AI-type** of information for this participant is demonstrated.

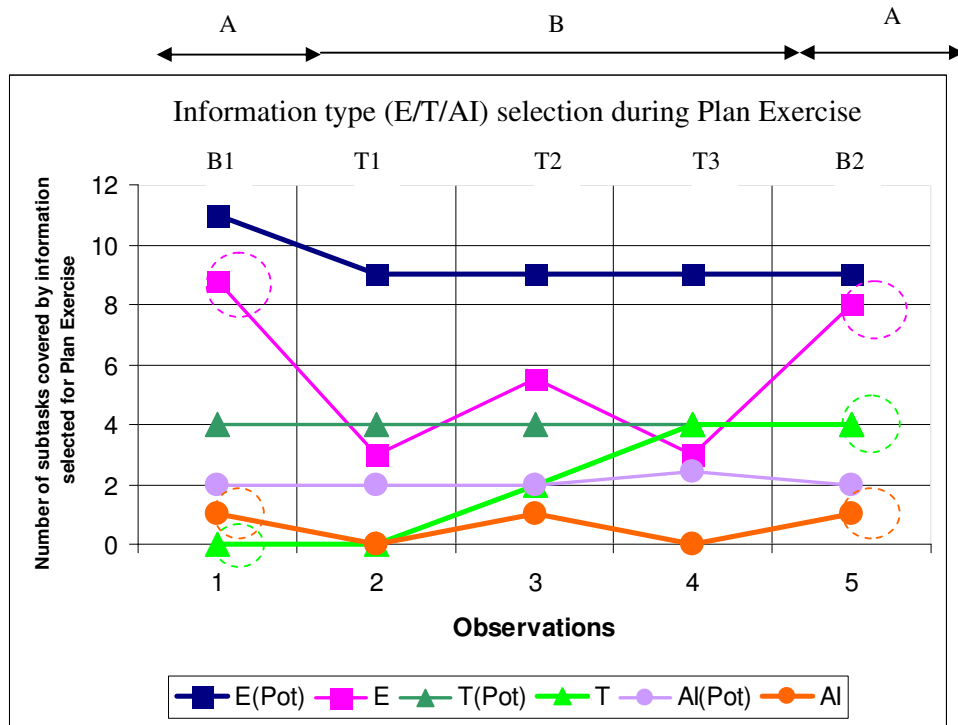


Figure 6.7 – Number of information type selected during the plan exercise.

Table 6.10 – List of Information Investigated to Plan

Experiment Phase	Time to complete plan in (min)	Information Selected to Plan
Real Journey 1 (B1)	6	1. London by Bus 2. Central London Bus Guide
Virtual Journey 1 (T1)	13	1. Google 2. Journey Planner
Virtual Journey 2 (T2)	14	1. Google 2. Journey Planner 3. A to Z
Virtual Journey 3 (T3)	10	1. Journey Planner 2. Complete Drawing Map Bus Stop to Hospital
Real Journey 2 (B2)	8	1. Journey Planner

But the plan is not considered to be the best output to explain the total of information processed before the journey. Therefore, a set of new curves was created: The ‘Pre-Journey’ curve, and ‘The Potential Curve’, illustrated in Figure 6.8.

Figures 6.8 (and 6.9) can illustrate an example of the curves extracted during the experiment. The curves are radar plots (as explained in Section 5.7) where each stage of the journey acts as a feature of the journey and the number along each axis reveals how many subtasks of each stage were covered by the participant’s use of information.

The ‘Minimum’ amount of information that can be assembled per stage is computed, including the information to cover essential (E) and time (T) only.

The ‘**Deviation**’ curve (explained in detail in Chapter 5) captures what, given his/her individual capabilities, the participant might be expected to select and process in order to deal with the environment capabilities required to complete each stage of the journey.

As explained in Chapter 4 (See Table 4.8, 4.9 and 4.11 and 4.12), each piece of information offers a particular set of information. The ‘**Potential**’ curve region is given by the total amount of information provided by all the pieces of information selected by the participant.

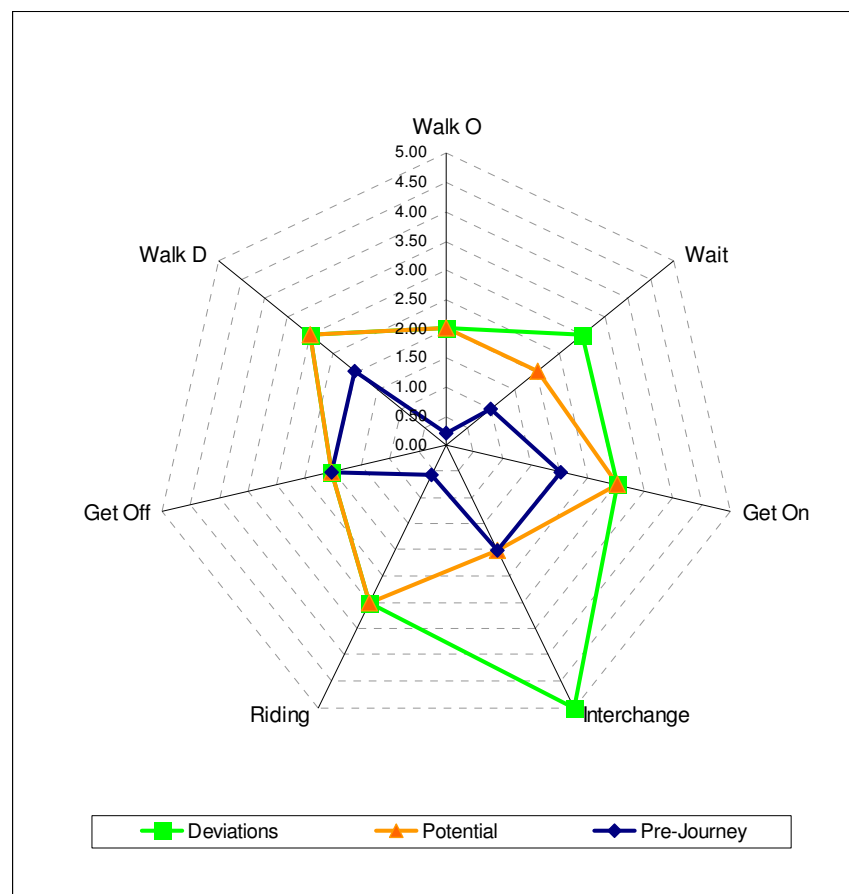


Figure 6.8 – Dimensions of Journey Chain (Before Journey)

By looking at Figure 6.8, it can be seen that the set of information selected to compose a plan (‘**Potential**’) is almost superimposed on the **Deviation** region (except for the ‘wait’ and ‘interchange’ stages), meaning that although the potential information selected is

sufficient for most stages of the journey, it is not enough to deal with the participant's deviations during the specific stages of wait and interchange in the journey.

To construct the '**Pre-Journey**' processed information, what the participant represented in the plan was used, together with the output of four specific tests: The Token Manipulation test, The Representation of Journey (before real journey), The Technical Questionnaire and the oral interview. The '**Pre-Journey**' processed information is the sum of all the selected and processed information.

In the example of Figure 6.8, the '**Pre-Journey**' curve is smaller than the '**Potential**' curve, meaning that this participant has not taken full advantage of all the information selected. The only stage fully covered in this respect is the 'get off' stage.

The relation between what one can capture from an information piece, the '**Pre-Journey**' information and what the information potentially provides, the '**Potential**' information is called in this study as 'Awareness of Information'.

$$\text{Awareness of Information} = \text{Pre-Journey Information} / \text{Potential Information} \quad [1]$$

The relation between the '**Pre-Journey**' processed information and the '**Deviation**' is called 'Awareness of Capability' (how much an individual is aware about his/her individual capabilities in order to deal with the environment Required Capabilities to complete each stage of the journey)

$$\text{Awareness of Capability} = \text{Pre-Journey Information} / \text{Deviation} \quad [2]$$

Both concepts are treated in Chapter 7 and 8.

For the examination of the execution of the journey an extra set of curves is constructed: The '**In-Journey**' curve and the '**Post-Journey**' curve and these are illustrated in Figure 6.9.

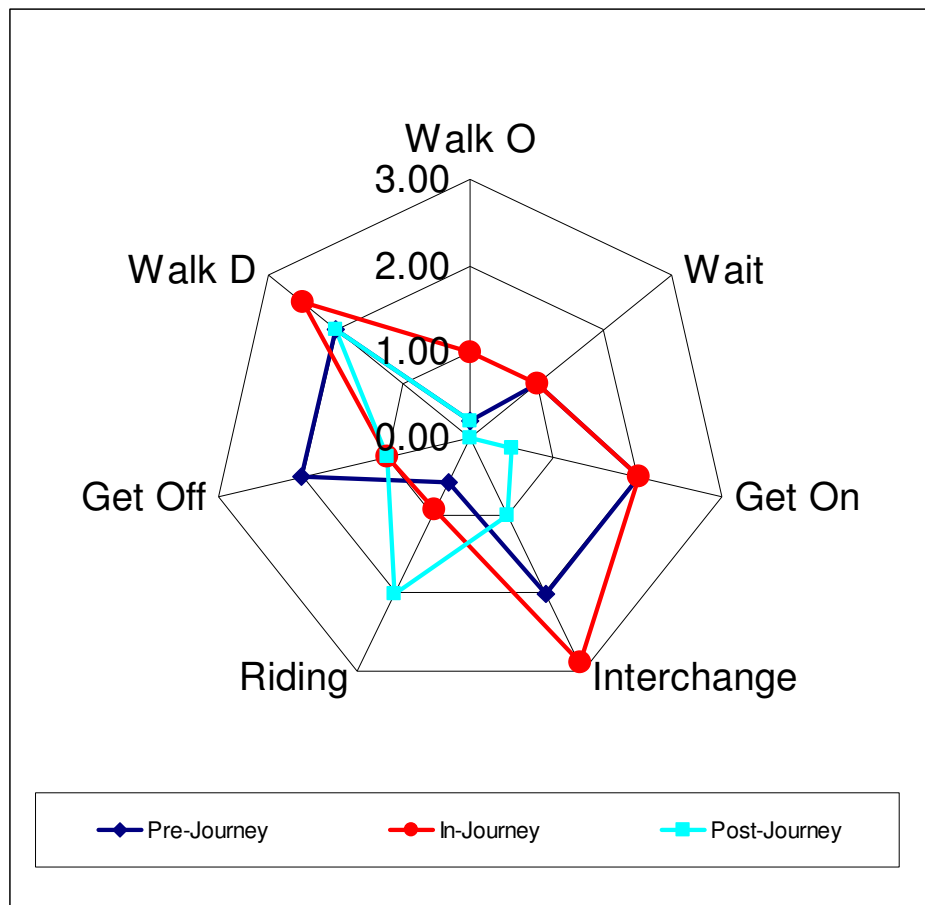


Figure 6.9 – Dimensions of the Journey Chain (Before and After the Journey)

The Interviewer Report (explained in Section 6.2.1.2) plus the participant's oral version of the journey execution constitutes the '**In-Journey**' curve. The report and the participant's version form the ultimate attempt to capture the real performance while the participant is executing the journey. Although they do not represent exactly what is done by the participant because it is impossible to capture the direct influence of environmental clues on the participant (e.g.: landscapes, signs on street, position of the sun), they are centred on the actions taken by participant and show some evidence of the use of information while executing the journey. Figure 6.9 reveals that the 'In-Journey' information differs from what was processed before the journey. The 'getting off' stage used less information than what was processed. And the 'interchange' and the 'walking to destination' consumed more during the journey than had been processed in advance.

Finally, the '**Post-Journey**' is characterised by the last representation of the journey constructed by participant, using the command (question 19, Table 6.3) to simulate the transference of information to an external person (e.g.: a friend who is unfamiliar with

the area). The curve illustrates worries about the stages, where the environmental cues (e.g.: landmarks) were most used and the stages that could make the journey more difficult: for example 'riding' and 'walking to destination'.

The curves, illustrated by Figures 6.8 and 6.9, compose the dimensions of the INFOChain journey. These are real examples obtained from one of the participants in the London case. Detailed presentation of results and analysis are described in Chapters 7 and 8 respectively for the London and Brasilia cases.

6.3.1 The analysis of the curves: how to exploit the curves?

The aggregated output extracted applying SCA is undertaken for each participant, to verify any improvement in planning during the whole experiment exercise. Similar outputs can be extracted considering not only the plan document but also what was processed before the journey, for example. The in-journey use of information is more difficult to be considered by the standards of SCA applications due to the significant source of variability caused by environment cues (objective and subjective aspects of the city environment). However, this particular influence of external variables is very important for the present work and was taken into account when the experiment was designed. Specific data collection of such variables is captured by INFOChain SCA/CM and considered to be a reasonable way to compare the use of information before and after the journey. The real participants' corresponding analyses are presented in Chapters 7 and 8.

The INFOChain curves extracted applying the SCA/CM can deliver more details about each stage of the journey chain and demonstrate the evolution of information acquisition before and after journey execution. Visually it shows which stage needs more attention, for example. It helps to verify if users are conscious of the journey chain and if they could extract better types of information from the system. More broadly, it can be applied to specific groups and could provide feedback in customised training sessions. Extending investigations, using between-participant analysis, can also be performed in order to verify the usability of Bus Information System provision to a number of people. In other words, to verify if the current Bus Information System offered by the Transport System is broadly delivering the necessary information to complete the desired activities.

6.4 VALIDITY AND RELIABILITY OF THE EXPERIMENT

In SCA, demonstration of a reliable effect (i.e., meeting the experimental criterion) is determined by replication of intervention over the course of the experiment. In practice, whether the results clearly meet the experimental criterion depends upon the pattern of the data in light of the requirements of the specific design. In the present study, the experimental criterion can be verified if the plan (and the interpretation of the plan) pattern includes accessible-information type, in other words, if the participant has accepted any kind of accessible information. Replications (2 more participants) were conducted in both environments (London and Brasilia). In practical terms of the journey, the experimental criterion can be verified if the participant arrived or not at destination in time, as explained in Section 6.2.1 – Baseline Phase.

With the purpose of checking content validity (and empirical validity – the match between experimental results and actual results) the methodology will be tested in different environments: (London/UK and Brasília/BR).

It is hypothesised that although the physical environment features of Brasília might be easier than in London (Brasilia is a planned city, Cartesian-tailored to help spatial knowledge) the city is not adapted to conform to Brazilian accessibility regulations (the environment is not accessible). Moreover, the lack of information provision (information is not accessible) would lead to low scores, showing that one or the other phase (planning or moving) might be inaccessible for participants.

Important points to consider when applying SCA/CM in different cities/countries:

- i. The content of accessible regulations should be explored: Differences between what regulation documents enforce and what is actually observed in real environment should be analysed.

In Brazil's case

- ii. The lack of information provision in Brazil will demand an alternative information provision created by the researcher in similar ways to the AI-type created in London environment.

For the Brazilian case it is necessary to repeat the design process: choose convenient journeys (with the same degree of difficulties) to explore accessibility levels of the city; do the environment inventories; translate the whole experiment to Portuguese and generate accessible information pieces comparable with London's information, with

necessary modifications and finally select a specialist group to judge interviewer' report generated during the real execution of the journey.

6.5 CONCLUSIONS

The domain of this study is more complex than similar examples found in the literature. Several studies involving information system acceptance and usability (Crosby *et al.* (1993) and Lyons *et al.* (2001)) together with the numerous studies of pedestrian movement in real and virtual environment (Hillier (1993), Penn (2003), Kuipers *et al.* (2003), Conroy (2001)) illustrate a fine sample of approaches to the problem domain. However, none of those studies was designed to tackle all the elements of a journey by bus, as tailored by Frye (1996), Ackerman (1995) and Tyler (2000), as the concept of the Journey Chain.

This chapter has described a framework in which the data is structured: tests to deal with individual influences and environment features and a prescribed format of tests to extract information use in different situations along all stages of the journey. Together, these two procedures provide a formal process of coding qualitative data (sorting information for analysis).

The questions raised in this chapter are treated per individual. The experiment is constructed to reveal the deep process of the way a unique person uses the information provided for the purpose for which the actual information system was constructed (i.e.: inform people about the transport mode functions and about the stages of the journey chain). The chapter has set out a method which allows the identification and exploration of issues related to the use of information pertaining to the relationship between a specific individual and the relevant environment. The method has to allow for the case in which the precise process applied by each individual could be quite different because of differences in capabilities and how these respond and/or affect the relationship to the environment. For this reason, Single Case Analysis has been supplemented by the use of the Capabilities Model so that these differences could be explored. The method is therefore considered at this stage to be useful for learning about the individual and the environment and is not intended to explore the similarities or differences between

different people. Comparisons between participants need to be analysed with care under these circumstances and generalizations with even more concern.

As suggested by Robson and Foster (1989), “there is a difference between what people say (responses) and the meaning or understanding behind what was said (interpretation). To exclude either totally is to present an incomplete piece of work. In order to handle the data on a deeper, more interpretative level, the researcher has to make judgements about the data.”

The methodology described in this and the previous chapters has taken Robson and Foster into account so that, by ensuring a meticulous and highly detailed disaggregated approach to the recording and coding of information obtained from the participants, the interpretation freedom required in the next chapters (7 and 8) can be achieved with a high degree of internal consistency.

7 INFOCHAIN-UK RESULTS: THE LONDON CASE

This chapter presents the results obtained in the INFOChain Experiment in London. The chapter starts by presenting the settings: the main features of the journeys (The Environment Capability Required) conducted by participants. In Section 7.2 the participants' profiles (overall health conditions, previous knowledge and experience, general performance indicators and feelings, The Individual Capability Provided) are explained in more depth in order to have a better understanding of the issues that apply in each case. Section 7.3 discusses each individual's choice towards information selection, their level of awareness, their coping strategy and feelings during the execution of the journeys (The Achievement of the Activity proposed). The last section closes the chapter with the main conclusions about the London Case.

7.1 EXPERIMENT SETTINGS: THE JOURNEY(S) ENVIRONMENT

This section presents the main features of each experiment journey. As explained in the last chapter, there were five distinctive journeys to plan. In the UK INFOChain experiments, the journeys are distributed around London, as illustrated in Figure 7.1. The origin is always the same, at UCL – University College London (WC1E) and the destinations are distributed according to the Figure 8.1. B1 and B2 are real journeys which participants actually executed and they constitute the object of study for the Baseline phases. T1 to T3 are called treatment-journeys, for which participants evaluated information in virtual-journey formats (refer to Section 6.2.2.2, Chapter 6). Table 7.1 describes the main features of real journeys B1 and B2. Experiments were conducted in April-May/2006.

Table 7.1 – Main feature of real journeys B1 and B2.

B1 - UCL to St Bartholomew Hospital

The journey is classified as difficult because of a long walk to the bus stop (~1 km or 10-15 minutes) or the need of the interchange stage (1 bus to Tottenham Court Road and another to Holborn). The environment is reasonably safe during day-light periods. The bus stops layouts are not appropriate to deal with user's demands in peak hours nor are they adapted to the platforms. Riding stage takes 8-10 minutes. The bus stop at destination is not adapted to low floor buses. At the destination bus stop site, the hospital is not evident but there are orientation signs indicating the path. The area is characterised as a mixed one (residential and commercial). The total walking distance from bus stop (S) to St Bartholomew Hospital is 221.0m. The pavers are in reasonable condition and the crossfalls are in general under 2.5%. The footways widths are variable but most of them with 3.0m wide.
Information provided: information at bus stops (timetable, spidermap, local map and countdown) plus orientation information at the destination.

Journey Without Interchange: Walk to Tottenham Court Road and get a bus to Holborn at Bus Stop Z. Visual and physical connections obstructed by physical barriers along path. Traffic and pedestrian flow are high. Six crossing points (4 without signals).

Journey With Interchange: Take bus in front of UCL and get off at New Oxford Street. Walk to bus stop Z and take another bus to Holborn. Cost added £ 1.20. Traffic and pedestrian flow are very high.

The journey can also be done via King's Cross (walking stage to bus stop is also around 1 Km but there are many more crossing point and the traffic levels are higher)

B2 - UCL to Marie Curie Centre

The journey is considered to be difficult because of a long walk to the bus stop (564m) and to the hospital (311m). Both walking stages have visual obstructions, cannot be seen straight from the bus stop. Walking at destination site is particularly difficult due to the bad state of footways (uneven and obstructed). The environment is reasonably safe during day-light periods. Bus stops layouts are not appropriate to deal with user's demand in peak hours nor are they adapted to low floor buses. The riding takes approximately 18 minutes.

Information provided: information at bus stops (timetable, spidermap, local map and countdown) plus orientation information at the destination.

Journey: Walk to Upper Woburn Place and get bus (168) at St Pancras Bus Stop (L) crossing 2 streets. Get off at bus stop G on Rosslyn Hill. Walk to Belsize Lane, turn right, cross 2 streets and arrive at Lyndhurst Garden.

The journey can also be done from Warren Street Bus Stop, using bus service 24, getting off near Fleet Road but the walking stage to the hospital is far worse, longer and steep. Walking to bus stop distance is around 300m and to the hospital is around 700m.

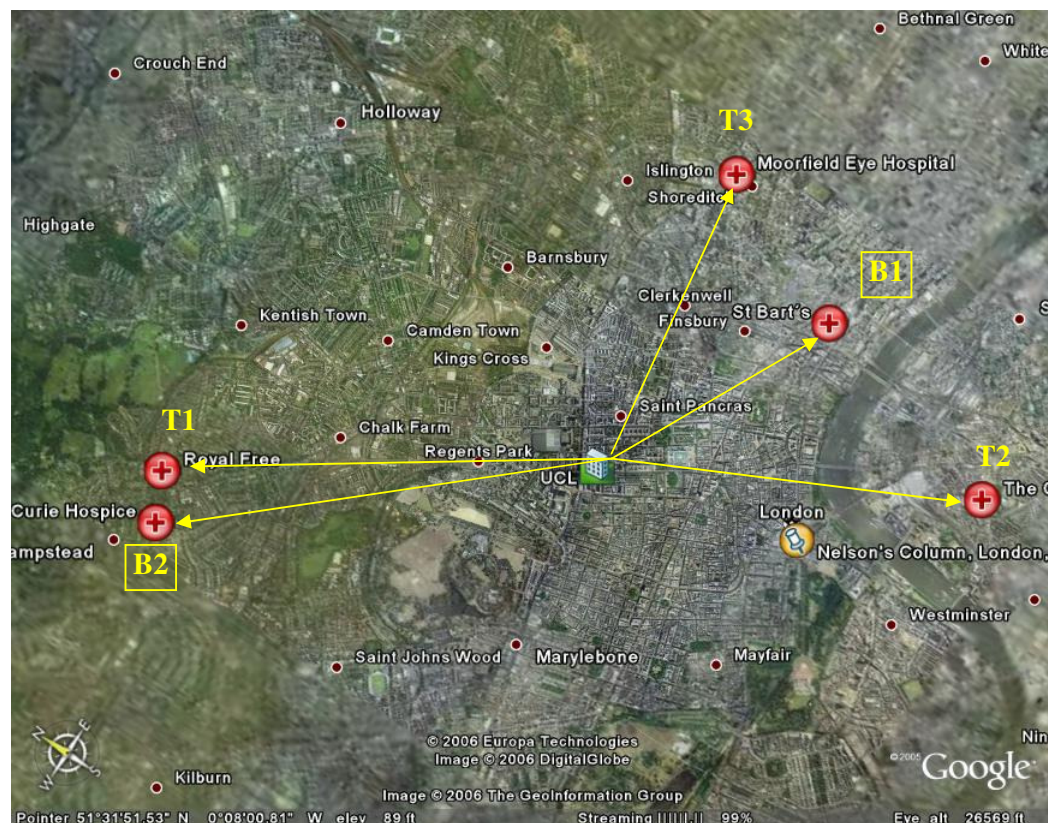


Figure 7.1 – Spatial Location of Hospital on Aerial Picture (Google_Earth)

Table 7.1 and Figure 7.1 summarises/illustrates the main features of the environment. A detailed printed version of each stage along each journey was built and presented to the participant when evaluating information along the journey chain (the virtual journeys, see Chapter 6, Section 6.2.2.2 for reference).

In the virtual-journey condition, each stage and the possible variants is explained for five experimental journeys, considering the different bus service choices and the walking paths taken by participants. Each stage is fully described in words, enriched by pictures of: the main objective physical characteristics found in the real condition (at the time of the experiment), emphasising the hazards, the accessibility issues and the main subjective social and psychological features of the environment (as explained in Chapter 5, Sections 5.6 and 5.7). All types of information piece (e.g. timetable, spider map, signs) found in the real environment or created to make the stage easier were also attached, following with pictures and appropriate explanation as illustrated in Chapter 6, Table 6.6a. All the virtual-journeys are assembled in a book-format.

In the real journey condition, each participant was asked to examine the virtual-journey manually, after the real journey exercise. While in the treatment phase they are asked to evaluate each stage of the journey (the virtual journey book).

The fully (virtual) descriptions of the five different journeys features constitute the Environment Capability Required to complete the journey in the real environment.

The next section describes the characteristics of the individual (participants).

7.2 THE PARTICIPANTS

Three participants responded to the request made by e-mail using UCL Alumni network: One 70 year-old man, one 73 year-old man and one 71 year-old woman.

7.2.1 Health Issues

Table 7.2 summarises the main health characteristics of the three participants. It lists the problems declared by the participant when prompted and the problems (impairment and competences) captured by the INFOChain Battery Test, explained in Chapter 5, Section 5.4.

Table 7.2 – Health Issues by participants

Personal Feature	Male 1 (70)	Male 2 (73)	Female 1 (71)
Declared Disease	Emphysema	None	Stroke (May/2005) & Tinnitus and Glaucoma
Declared Impairment	i. Short sighted ii. Breathing problems iii. Walking problems (ankle)	None	i. Memory disorder: typical of old age ii. Visual impairment: double vision, short sight iii. Hearing impairment: tinnitus iv. Impairment in superior members: left hand a bit weak v. Breathing problems: occasionally
Impairments Detected by Battery Tests (Chapter 5)	Physical Impairment: i. Walking-speed: Mild impairment [0.25]	Physical Impairment: None	Physical Impairment: None
	Visual impairment: ii. Near vision: Mild impairment [0.20] iii. Peripheral Vision: Moderate impairment [0.40] iv. Stereopsis: Profound impairment [1.00] v. Colour-acuity: Moderate impairment [0.40]	Vision Impairment: i. Near vision: Mild impairment [0.20] ii. Peripheral Vision: Mild impairment [0.25] iii. Colour-acuity: Moderate impairment [0.40]	Vision Impairment: i. Near vision: Severe impairment [0.60] ii. Distant vision: Mild impairment [0.20] iii. Peripheral Vision: Moderate impairment [0.40]
	Audible Impairment: vi. Following instructions: Mild impairment [0.25]	Audible Impairment: iv. Following instructions: Mild impairment [0.25]	Audible Impairment: iv. Following instructions: Mild impairment [0.25]
	Cognitive Competence: vii. Long Memory Term: Weak competence [0.24] viii. Public Transport Knowledge : Weak competence [0.33]	Cognitive Competence: v. Long Memory Term: Weak competence [0.24] vi. City Knowledge: Weak competence [0.32] vii. Public Transport Knowledge : Weak competence [0.33]	Cognitive Competence: v. Long Memory Term: Medium competence [0.44] vi. Imagination: Medium competence [0.48] vii. Spatial Competence: Weak competence [0.32] viii. Public Transport Knowledge : Weak competence [0.25]

The subsequent tables show more specific data about the experiment: Knowledge and experience (general and specific knowledge about hospital area), general feelings about the Journey Chain and indicators about performance.

7.2.2 Knowledge and Experience

This section explores objective and subjective measures of knowledge and participant's experience with Public Transport and their specific feelings about bus system (Table 7.3). Knowledge related to the area where the journeys were executed is demonstrated in Table 7.4. The measures were captured during the Battery Test (Chapter 5, Section 5.4).

The first three topics from Table 7.3 were obtained by interview during Battery Test application and the last three topics correspond to tests #9 (Participant's objective (item 4) and subjective opinions (item 5) about the Public Transport System)) and #8 (City Spatiality Knowledge) from the Battery Test, explained in Sections 5.4.9 and 5.4.8 of Chapter 5. No huge difference between participants in terms of background knowledge was registered: they were used to the environment and to the bus system although they did not reveal very good knowledge about either public transport or the city spatial distribution according to the results obtained in the battery tests. The feelings towards bus systems were positive and high (8 in a scale [0-10]).

Table 7.3 – Declared Background Knowledge

Background Knowledge	Experiment		
	Male 1 (70)	Male 2 (73)	Female 1 (71)
1. Time living in London	60 years	73 years	42 years
2. Experience with PT	60 years	20 years	60 years
3. Frequency of use PT	everyday	> twice/w	3 to 5/w
4. General Knowledge about PT	poor	poor	poor
5. Feeling towards bus system	Positive [8]	Positive [8]	Positive [8]
6. City Spatiality Knowledge	medium	weak	weak

Specific knowledge declared about the target area was very variable, as shown in Table 7.4 but it is an important parameter for the understanding of information use (selection, process and use), as will be presented in the next sections.

Table 7.4 – Previous Knowledge Declared of Destination Area (Scale [0-10])

Journeys	UCL to	Post Code	Knowledge		
			Male 1 (70)	Male 2 (73)	Female 1 (71)
Real Journey 1	St. Bartholomew	EC1A 7BE	9	7	1
Virtual Journey 1	Royal Free	NW3 2QG	3	7	7
Virtual Journey 2	Gainsborough Clinic	SE1 7PW	0	0	0
Virtual Journey 3	Moorfields Eye	EC1V 2PD	4	0	0
Real Journey 2	Marie Curie Hospice	NW3 5NS	0	0	0

7.2.3 Feelings

Two other important parameters for the analysis of information use are the binomial Risk Perception and Risk Behaviour towards the Journey Chain. Table 7.5 illustrates the code to interpret results obtained using a technique suggested by Webber (2002), explained in Chapter 5, Section 5.4.11. Table 7.6 illustrates the Participant's Risk Perception and Table 7.7 illustrates the Participant's Risk Behaviour along the stages of the Journey-Chain.

Table 7.5 - Scale and interpretation used to measure risk perception and behaviour

How risky you perceive each situation?				
1	2	3	4	5
Not at all risky	Mildly Risky	Moderately	Risky	Extremely Risky

Likelihood of engaging in each activity or behaviour				
1	2	3	4	5
Very Unlikely	Unlikely	Not sure	Likely	Very Likely

Table 7.6 – Risk Perception per stage

Stages	Male 1		Male 2		Female 1	
Planning	3.20	Moderate Risky	3.20	Moderate Risky	1.60	Mildly Risky
Walking O	4.00	Risky	3.60	Risky	3.60	Risky
Waiting	3.80	Risky	4.40	Risky	3.00	Moderate Risky
Getting On	1.80	Mildly Risky	2.40	Mildly Risky	2.20	Mildly Risky
Interchange	2.47	Mildly Risky	3.07	Moderate Risky	2.47	Mildly Risky
Riding	1.60	Mildly Risky	4.00	Risky	2.20	Mildly Risky
Getting Off	1.80	Mildly Risky	2.40	Mildly Risky	2.20	Mildly Risky
Walking D	4.00	Risky	3.60	Risky	3.60	Risky

Table 7.7 – Risk Behaviour per stage

Stages	Male 1		Male 2		Female 1	
Planning	3.20	Not sure	2.60	Not sure	3.80	Likely
Walking O	2.20	Unlikely	2.00	Unlikely	2.60	Not Sure
Waiting	2.00	Unlikely	1.60	Unlikely	1.80	Unlikely
Getting On	4.40	Likely	3.40	Not sure	3.80	Likely
Interchange	3.60	Likely	2.93	Not sure	3.13	Not Sure
Riding	2.60	Not sure	2.00	Unlikely	1.60	Unlikely
Getting Off	4.40	Likely	3.40	Not sure	3.80	Likely
Walking D	2.20	Unlikely	2.00	Unlikely	2.60	Not Sure

All participants evaluated at least two risky stages in the journey chain and declared that they were either unlikely or not sure to engage in these stages to complete the journey. Walking stages were considered a risky stage by all participants. The waiting stage was termed as ‘unlikely engaging on the activity’, demonstrating the impact of this stage on mode choice decisions, for example, confirming one of the topics in user satisfaction (Horbury, 1999). It can be inferred from Table 7.7 that the waiting stage is a disadvantaged characteristic for the bus mode, according to the 3 participant’s opinion.

Sections 7.2.1 (Health issues), 7.2.2 (Knowledge) and 7.2.3 (Feelings) are the set of characteristics considered by this study to constitute the main Individual Capability Provided. The set of individual’s characteristics considered to be related to the proposed activity: the execution of a journey by bus in real environment. Section 7.2.4 presents the general performance indicator (time) to complete the experiment.

7.2.4 Performance Indicators

The general experiment performance is given by the total experiment time (Table 7.5) and the time taken to finish the plan exercise only (Table 7.6).

Tables 7.8 and 7.9 show that the female participant has taken twice the time to complete the experiment when comparing with Male-01 and 3 hours more than Male-02. Her planning time was also longer in most of the phases, and particularly long in the first baseline phase (41minutes) what can be explained by the novelty of the task or by the ‘observer impact’ on participant’s behaviour, as mentioned in Chapter 6 (Section 6.2.1.2). The time issue was discussed in the post experiment interview but she just said that she was lost using the information and could not maintain the focus when she inspected more than one information piece (which might be explained by her cognitive competence profile, presented in Table 7.2).

Table 7.8 – UK INFOChain Experiment Total Time (hours and min)

Experiment Total Time (min)	Male 1 (70)	Male 2 (73)	Female 1 (71)
Compact Battery Test	92	155	176
Real Journey 1	98	137	206
Treatment	149	177	240
Real Journey 2	58	106	131
Total time (min)	397	575	753
Total time (hours)	6h 37min	9h 35min	12h 33min

Table 7.9 - Planning Task Time (min)

Journeys	UCL to	Post Code	Planning Task Time (min)		
			Male 1 (70)	Male 2 (73)	Female 1 (71)
Real Journey 1	St. Bartholomew	EC1A 7BE	6	8	41
Virtual Journey 1	Royal Free	NW3 2QG	13	7	10
Virtual Journey 2	Gainsborough Clinic	SE1 7PW	14	22	15
Virtual Journey 3	Moorfields Eye	EC1V 2PD	10	8	28
Real Journey 2	Marie Curie Hospice	NW3 5NS	8	8	21
	AVG/participant		10.2	10.6	23

The next section examines the individual choices made to complete the proposed activity: the selection and process of information pieces to plan the journey and the choices/coping strategies made in the real environment when executing the planned journey. They constitute the achievement of the activity proposed given the interaction between the capability provided and the environment capability required.

7.3 THE INDIVIDUAL CHOICE

Each participant's choices are explored in this section. The analysis starts by revealing the type of information investigated to solve the problem (plan and do a journey by bus) during the five phases of the experiment (real journeys and treatment phases, explained in Chapter 6). In the sequence, some detailed analyses (restricted to real journey phases, B1 and B2) are presented to demonstrate the relation between INFOChain curves: Deviation (theoretical interactions between individual and environment); Pre-Journey information before journey execution (accumulated: selected and process); In-Journey, used in order to complete the activity (do the journey by bus) and Post-Journey information evidence of what information was stored in long-term memory. Finally some comments are made taking into account the feelings declared by each participant for each real journey.

The first participant's results (Male_01) are presented in detail in order to illustrate how the analysis was carried out, the other two participants' results are summarised and only the main differences and conclusions are presented in this chapter. Main conclusions about the London Case are presented at the end of this chapter.

7.3.1 Male-01's Case

7.3.1.1 Selection of information to compose the plans (General Analysis)

Table 7.10 lists the information pieces selected to compose the plan for each journey exercise. The table also resumes the subjective participant's opinion about the quality of his plan (test # 6, Table 6.2) and the degree of difficulty to plan (test # 7 of Table 6.2).

As explained in Chapter 6, both "Degree of Difficult to Plan" and "Plan Quality" are subjective parameters captured using a scale from [0 to 10] ([0 very easy and 10 very difficult] and [0 very poor and 10 very good], respectively).

Table 7.10 illustrates that participant initiated the experiment using traditional printed information. In the first two attempts to use Journey Planner the participant declared some difficulties, but after the third attempt, the plan activity turned out to be an easy task. In general, he was happy with the quality of the resulting plan.

Table 7.10 – List of Information Investigated to Plan

Experiment Phase	Time (min)	Degree of Difficulty to Plan (Test # 7) [0-10]	Information Selected to Plan	Plan Quality (Test # 6 participant's subjective opinion) [0-10]
Real Journey 1 (B1) (Interchange)	6	1 [very easy]	3. London by Bus 4. Central London Bus Guide	10 [very good]
Virtual Journey 1 (T1)	13	7 [regular]	i. Google ii. (AI) Journey Planner	10 [very good]
Virtual Journey 2 (T2)	14	7 [regular]	i. Google ii. (AI) Journey Planner iii. A to Z	10 [very good]
Virtual Journey 3 (T3)	10	4 [easy]	i. (AI) Journey Planner ii. (AI) Complete Drawing Map Bus Stop to Hospital	7 [regular]
Real Journey 2 (B2) (No Interchange)	8	2 [easy]	i. (AI) Journey Planner	9 [very good]

Table 7.10 shows that, on some occasions (T2 and T3), the participant complemented Journey Planner with traditional information, mostly to be used at the very last stage of the journey (the Walking to Hospital stage).

Figure 7.2 shows the potential amount of each type of information (PotE/PotT/PotAI) provided by information pieces selected by participant and the amount actually used to

compose the plan (E/T/AI). No evidence of improvement in the selection of the AI-type attributes was demonstrated by the participant (comparing B1/B2).

High levels of the E-Type of information in the first journey (B1) might reflect the initial contact with the experimental procedures and the fact that the journey has an extra stage, the interchange, chosen by the participant. High levels of the E-type and the T-type in the third journey (T2), as well as the extra time needed for planning, can be explained by the total unfamiliarity with the area, as declare by the participant (Table 7.4). According to SCA experimental criteria, no evidence of the importance of the AI-type information during the selection of information pieces was demonstrated when comparing baselines.

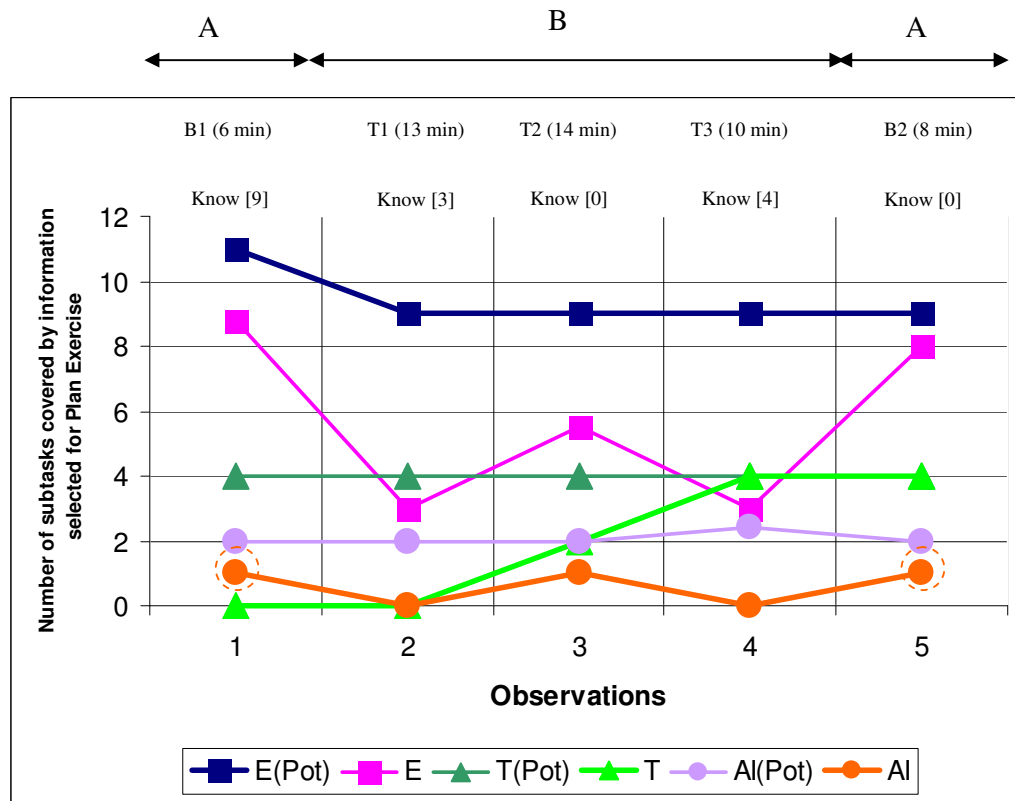


Figure 7.2 – Single Case Results: (Potential & Selected) Information by Male_01

Figure 7.2 is the graphic representation of the selection of information (the plan: written/oral, ‘the behaviour observed’ for the application of the Single Case Analysis, as explained in Chapter 6, Section 6.3).

Table 7.11 illustrates the importance of information captured considering the whole journey chain. In B1 and B2 phases, the importance of information was captured before

execution (question # 10, Table 6.2, Chapter 6) and after execution of the real journey (question # 23, Table 6.2, Chapter 6). In T1 and T2 phases, the importance of information for the whole journey was captured only before virtual-journey analysis. In the T3 phase, a completely different format to capture information importance was used, as explained in Chapter 6 (Section 6.2.2.3), based in monetary tokens.

Table 7.11 – Information Importance (whole Journey-Chain analysis)

Experiment Phase	Information Importance (whole Journey-Chain analysis)	
B1	Before Journey i. Area Bus Guide (London Buses)	After Journey (Virtual Journey Analysis): i. (AI) Complete drawing map origin to interchange ii. (AI) Route with landmarks (to know when to get off) iii. (AI) Pictures sequence to interchange iv. Timetable for frequency
T1	Before Journey: i. (AI) Journey Planner ii. (AI) JP (duration of the journey inside vehicle)	
T2	Before Journey i. (AI) Journey Planner ii. A to Z iii. (AI) Drawing Sequence of the path to Hospital	
T3	Information selected: i. (AI) Journey Planner (2T) ii. (AI) Complete Drawing map origin to bus stop (2T) iii. (AI) Complete Drawing map bus stop to hospital (2T) Total tokens selected: 6T	Information bought: i. (AI) Journey Planner, ii. (AI) Complete Drawing map bus stop to hospital Total tokens given to participant: 4T
B2	Before Journey: i. (AI) Journey Planner ii. (AI) Complete drawing map from bus stop to hospital iii. (AI) Complete drawing map from origin to bus stop	After Journey (Virtual Journey Analysis): i. (AI) Journey Planner i.i Name and Letter of Bus Stop at origin i.ii Name and Letter of Bus Stop at destination. ii. (AI) Picture of Bus Stop where you get your bus

It is perceived that AI-type information is consistently considered important in all phases of the experiment.

Table 7.12 reveals some details during the treatment phase of the experiment. As explained in the treatment phase (Chapter 6, Section 6.2.2), the objective was to sensitise the participant to accessibility-oriented types of information (AI-type). In this phase of the experiment, information availability was analysed by stage and the emphasis was on the importance of the information (evaluated by a scale from 0 to 10). The risks associated in each stage were also assessed (See Tables 6.6a and 6.6b, for reference).

Table 7.12 shows that this participant has considered AI-type of information, produced for the experiment, the most useful type of information in all stages for the two first treatment journeys and he was able to identify the hazards involved in the different stages of the journey. The values express the importance evaluated by the participant in a scale from 0 to 10, as explained in Chapter 6 (Table 6.9, Section 6.2.4). One of the hazards identified drew his attention - “Steepness at Pond St” - because it was related to his physical problem with his ankle. Nevertheless, the usefulness of the produced AI-type information was only apparent (i.e.: it was not translated into the individual’s strategy improvements). It can be concluded that this type of information was not transferred to the selection/process of information, in the return to baseline condition (Baseline 2), as illustrated by Figure 7.2 and Table 7.10. Although his option to plan the last journey was to choose the more accessible type of information (Journey Planner) provided by the current transport system, no use of such kind of AI-type information was revealed in the plan (i.e.: the effective transference of the information piece to the plan w/o was not observed)

Table 7.12 – Most Important Information selected during Treatment Phase

Journey	T1		T2	
Stage	Most important Information	Risk	Most important Information	Risk
Walking	(AI) Complete path drawing to bus stop [8]	Traffic accident	(AI) Complete path to Bus Stop [8]	Traffic accident
Waiting	Route (schematic) [10]	Traffic accident	(AI) Where to catch your bus [8]	-
Getting on	(AI) Nearest accessible bus stop indication [8]	-	-	Access due to geometry
Riding	(AI) Route with landmarks [8]	i. Traffic hold ups ii. Missing destination stop	(AI) Landmarks picture sequence [8]	-
Getting off	(AI) Nearest accessible bus stop indication [7]	Get off at wrong stop	-	-
Walking	(AI) Sequence of pictures of the path to final destination [9]	Steepness at Pond St	(AI) Description of the path to final destination [8]	Traffic accident

The next Subsections 7.3.1.2 and 7.3.1.3 explore the results obtained with the real journey exercises (B1 and B2): The set of information pieces investigated to compose the plan (Potential Information); What was selected for the journeys (Selected Information) what was processed before initiating the real journey exercise (Pre-Journey Information); what was used during the journey (In-journey Information) and what was retained after the journey execution (Post-Journey Information).

7.3.1.2 Results from Real Journey 1: UCL to St Bartholomew

A brief description of the journey was introduced in Section 7.1. Table 7.13 illustrated the set of information selected to construct the plan for this first journey: ‘London by Bus’ + ‘Area Bus Guide’, official information type, provided by London Transport and available at newspaper agents.

The two pieces of information (London by Bus +Area Bus Guide) potentially provided specific types of information (See Table 7.13 and Table 4.8 for reference). This participant has selected a sub-range of information (correspondent subtasks and the types E/T/AI) that he has considered important to represent on his plan. As extensively discussed before (on Chapter 6, Sections 6.1 and 6.2) not all information processed is represented on the plan, therefore a set of measures (tests) were taken into account to extract the information processed but not formally represented on the plan. The Pre-Journey information processed (before initiate the real journey) is given by information selected (the plan, written and oral version) and information processed (assessed by tests).

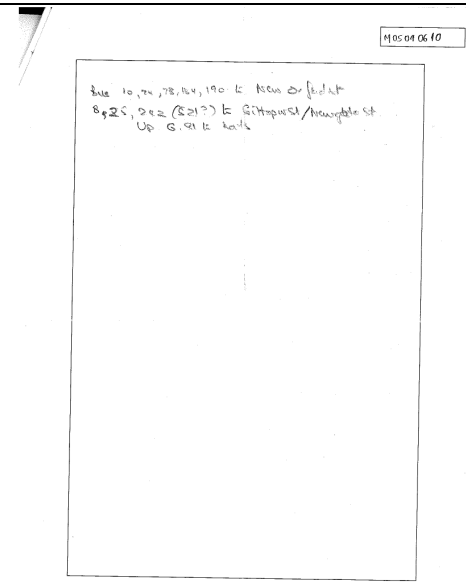
Table 7.13 – Information Gathered to Initiate Journey B1

REAL JOURNEY B1 Information Used to Compose PLAN: London by Bus + Area Bus Guide							
Stage	#	Type of Information		Potential	Selected	Processed	Selected + Processed
Walk (O)	1	Path identification Information	E	1		0.20	0.20
	2	<i>Distance (time) to walk</i>	T	1			
Wait	9	Bus Stop Identification	E	1		1.00	1.00
	13	<i>Waiting time</i>	T	1			
Get On	15	Bus Service Identification	E	1	1.00	1.00	1.00
	16	<i>Bus Type</i>	AI	1			
	17	Cost	E	1		1.00	1.00
Interchange	20	Path identification	E	1	0.20	1.00	1.00
	21	Bus Service Identification	E	1	1.00		1.00
	24	<i>Landmarks References</i>	E	1			
Ride	25	Direction	E	1	0.20	0.58	0.58
	26	<i>Distance (time or km)</i>	T	1			
Get Off	28	Landmarks References	AI	1	1.00	1.00	1.00
	29	Bus Stop Identification	E	1		1.00	1.00
Walk D	32	Path identification	E	1	0.20	1.00	1.00
	34	<i>Distance to walk</i>	T	1			
	40	Target (Hospital) Identification	E	1	1.00	1.00	1.00
TOTAL				17	4.60	8.78	9.78
Total E				11	3.60	7.78	8.78
Total T				4	-	-	-
Total AI				2	1.00	1.00	1.00

Table 7.13 is the individual's smaller version of the complete INFOChain Taxonomy (Table 4.6 presented in Chapter 4). The potential information provided by the information pieces selected by the participant, covers only 17 (attributes that were covered by the set of information pieces selected, see Chapter 4, Table 4.8 – London Bus Information System) of the total 40 subtasks to complete the journey.

The total representation of the information selected, the information formalised by the written and oral version of the plan, is 4.60. Table 7.14 illustrates the participant's plan. For example: the subtask 'path identification information' is not formally represented in the plan, therefore the subtask's value is zero (or blank). The plan (w/o) only formalised bus service, part of the interchange stage, some sort of direction for the riding stage, landmarks references to get off and the hospital reference (the target point). The plan score is revealed comparing what was formally represented in the plan with the list of attributes/subtasks presented in INFOChain Taxonomy (Table 4.6). Each stage has a number of attributes/subtask. The values of each subtask can vary between [0] not covered or not present to [1] fully covered or present (0.5 when it is partially covered and 0.2 when it can only be inferred).

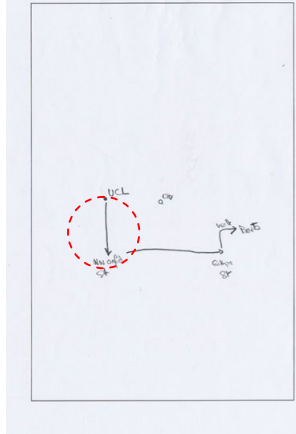
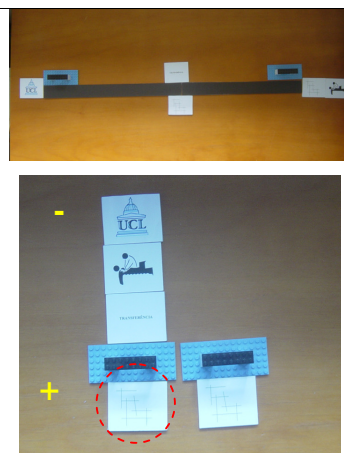
Table 7.14 – Outputs extracted during planning exercise

The Plan Sheet	Details of the plan
	<p>Bus 10, 74, 78, 154, 190 to New Oxford St 8, 25, 242 (521?) to Giltspur St/Newgate St Up G. St to Bart's</p> <p>Transcription:</p> <p>Bus: 10, 74, 78, 154, 190 to New Oxford St. 8, 25, 242, (521?) to Giltspur St/Newgate St. Up G. St to Bart's.</p> <p>Oral version: "Get any bus (from the list) to New Oxford Street, and then get any other bus (from list) to Giltspur Street."</p> <p>Extra questions:</p> <p>No difficulties were perceived. Personal strategy if problem occurs: Ask around. Bus reliability [0-100%]: 100% confident he would arrive at the destination on time.</p>

The same rationale was used for the score obtained for the information processing before the journey execution, represented by column ('Selected+Process', Table 7.13). Table 7.15 illustrates the three main outputs obtained during the application of the tests to extract information processing before the journey execution: The Representation of Journey, The Token Manipulation and The Technical Questionnaire. They were also scrutinised using the same attributes of the INFOChain Taxonomy (Table 4.6, Chapter 4). For example, considering the 'walking to bus stop' stage of Table 7.13; the 'path identification' subtask was computed to be 0.20. The information content to evaluate the subtask was not evident in the plan (w/o), but it could be inferred from the 'Representation' of the journey test and by the 'Token' picture (both in Table 7.15) that the participant knew its importance, although he has not formally represented it in detail. The more evident the content of the subtask is demonstrated the higher is the score attributed to it. The value is obtained by the maximum value between the three outputs because the outputs are complementary, meaning that: what can not be spotted in one test could be spotted in the other and they together demonstrated what was processed by the participant before executing the journey. Considering only the plan (w/o) this attribute ('path identification') was not covered at all. On the other hand, no reference to 'duration (time) to walk' was found in any test applied.

The application of tests that could capture the processed (but not obvious) information accumulated before journey, presented in Chapter 6, Table 6.2, is crucial for understanding the knowledge the participant has to execute the activity proposed.

Table 7.15 – Tests outputs - extracted (processed) information before journey

Representation of Journey	Token Manipulation	Technical Questionnaire																		
<p>14. Now that you have planned your journey, please represent it on the space below. You can use the representation of London you did before or you can use this new space.</p> 		<table><tr><td>How to arrive at bus stop</td><td>Walk</td></tr><tr><td>Bus #</td><td>168</td></tr><tr><td>Departure</td><td>don't know</td></tr><tr><td>Frequency</td><td>every 6-7 minutes</td></tr><tr><td>Duration trip inside bus</td><td>24 min</td></tr><tr><td>Where to get off</td><td>Arrive <u>att</u> RHF</td></tr><tr><td>How to arrive at destination</td><td>Walk</td></tr><tr><td>Duration of the journey</td><td>39 min</td></tr><tr><td>Cost</td><td>free pass</td></tr></table>	How to arrive at bus stop	Walk	Bus #	168	Departure	don't know	Frequency	every 6-7 minutes	Duration trip inside bus	24 min	Where to get off	Arrive <u>att</u> RHF	How to arrive at destination	Walk	Duration of the journey	39 min	Cost	free pass
How to arrive at bus stop	Walk																			
Bus #	168																			
Departure	don't know																			
Frequency	every 6-7 minutes																			
Duration trip inside bus	24 min																			
Where to get off	Arrive <u>att</u> RHF																			
How to arrive at destination	Walk																			
Duration of the journey	39 min																			
Cost	free pass																			

In Table 7.13, the last column (information selected and processed by the participant before the execution of the journey) follows the same rationale: each attribute present was the maximum value between what was selected and processed. Information highlighted in red italics are the ones not represented: neither processed by participant (they were not formally represented in the plan) nor appearing in the tests to extract processed information. From the 17 attributes that could be potentially used only, 4.60 were formalised in the plan representation, representing 27% (a weak process level, according to Table 7.16). Further investigation concluded that almost double this amount was processed (8.78) which represents 57% of what the set of information could offer – a regular process level, according to Table 7.16.

Table 7.16 – INFOChain Classification of Processing Level of a Journey Plan

Level of process based on the potential information investigated	Interval
Total Process	100%
Good Process	]100% to 75%]
Regular Process	] 75% to 50%]
Weak Process	] 50% to 25%]
Poor Process	] 25% to 0%]

In traditional studies about awareness (e.g: Eagan, 2003 and Balcombe, 1998) awareness is expressed as knowledge someone has about a topic, therefore the 27%, can be used to quantify awareness of information, meaning the percentage of information needed to execute the journey, captured by the plan exercise.

In the INFOChain methodology, the concept of awareness is not so simple and it is treated differently. As explained in Chapter 2 (Section 2.5) awareness is “...the potential user’s state of knowledge and perception about a service and its characteristics.” The tests developed to capture information processing (Table 7.15) were used to demonstrate the individual’s awareness of information.

As exposed in Chapter 5 and 6, this study has used multiple techniques to extract the individual’s knowledge/perceptions/feelings about the journey chain and transport system. Additionally, features such as perceived risk, declared knowledge (before the journey tests), acquired knowledge, attention and anxiety (after the journey tests) are therefore introduced in the analysis of awareness. At the end of this section, more comments about awareness will be given.

Table 7.17 illustrates the INFOChain Awareness of Information, disaggregated by stages of the B1 Journey Chain. Figure 7.3 illustrates the difference between information processed (‘**Pre-Journey**’) and information provision (‘**Potential**’). The surface is represented by a radar diagram where each axis correspond to one stage of the journey and each stage scores the total of subtasks (attributes) represented in each phase of the experiment.

Table 7.17 – Awareness of Information per Stage

B1 Stages	Real Info	Information	AWARENESS Of INFORMATION
	Investigated	Processed	
	Potential	Pre-Journey	
Walk O	2.00	0.20	10.00%
Wait	2.00	1.00	50.00%
Get On	3.00	2.00	66.67%
Interchange	2.00	2.00	100.00%
Riding	3.00	0.58	19.33%
Get Off	2.00	2.00	100.00%
Walk D	3.00	2.00	66.67%
TOTAL	17.00	9.78	57.53%

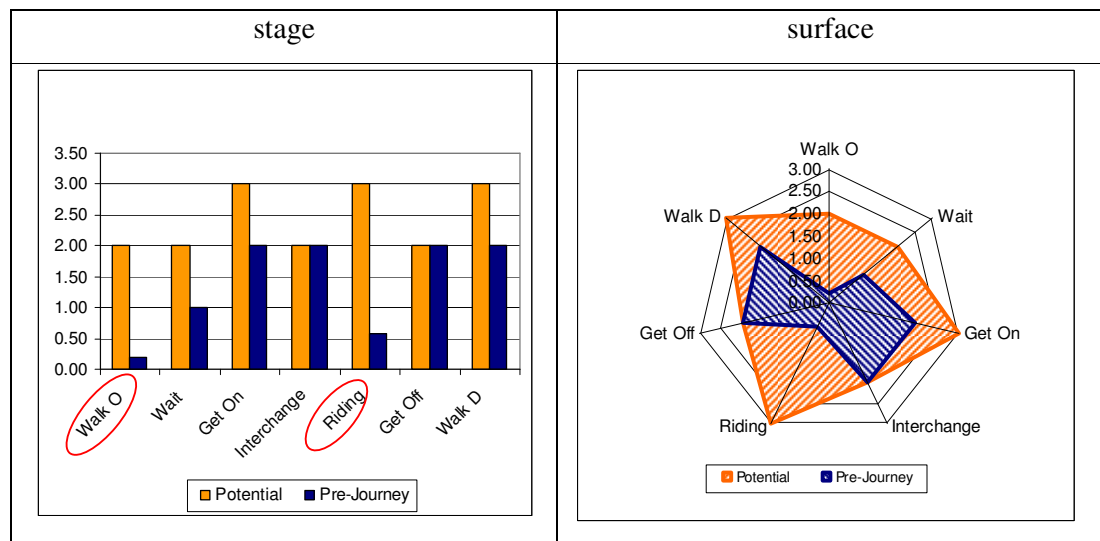


Figure 7.3 - Awareness of Information, before journey, B1

Two stages revealed very low awareness of what information can offer: ‘Walking to Bus Stop’ and ‘Riding’ stages.

Figure 7.4 illustrates the approach adopted by INFOChain: the curves which translate the individual use of information for this specific journey. According to the outputs of the SCA/CM application, the area of the journey that should be covered by this specific

participant was **SDev** ('Deviations'), which represents what should be processed to deal with individual's limitation required by the specific environment (UCL-St Bart's) where the journey was executed. The construction of the deviation curve was explained in Chapter 5, Section 5.7. The graphic also shows that the area of 'Potential' information investigated (**SPot**) does not cover all the stages recommended by deviations (for example, the stages 'Waiting' and 'Interchange' are ignored). For the Interchange stage, the Potential region does not cover even the minimum (dotted line) of information recommended to complete it. As a whole, it can be said that Potential information investigated for this journey is close to the information necessary to execute the journey indicated by the deviation curve, except for the Interchange stage, where the participant might encounter some difficulties in overcoming the stage.

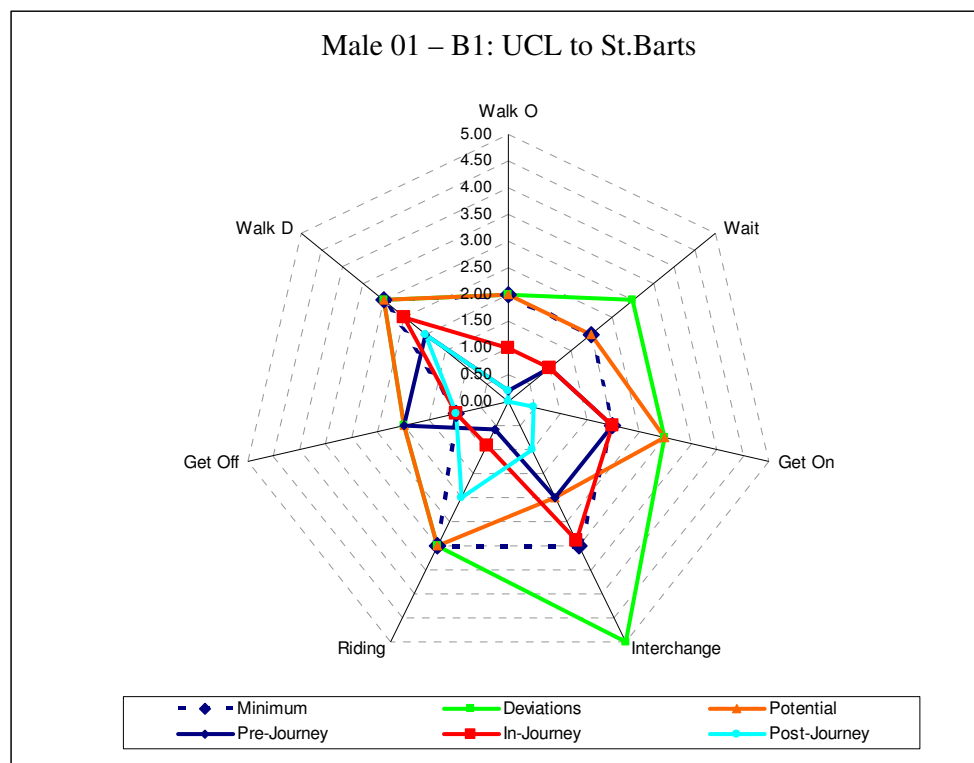


Figure 7.4 – Different Types of Information Manipulation, B1

Figure 7.5 illustrates, in more detail, the relation between the information manipulated before the journey using the curve and surface illustrations.

The 'Pre-Journey' information processed (**SPre**) can be considered the total amount of information load for the participant to execute the journey. As can be seen by Figure 7.5, it is less than the potential information could have provided and even less than the

participant should have considered (given by the interaction between his individual capability provision and environment capability required) to complete the journey.

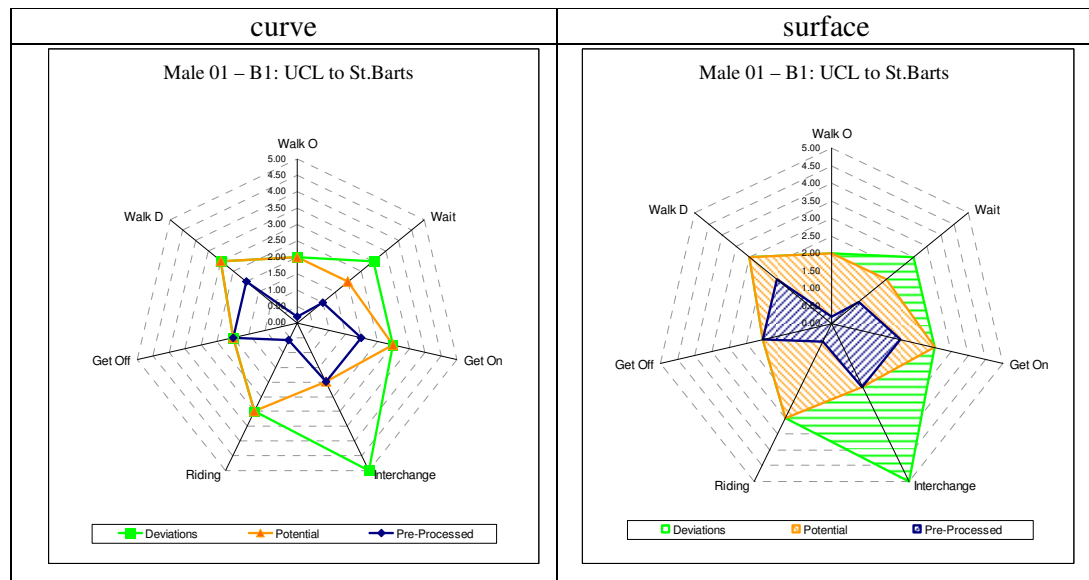


Figure 7.5 – Information manipulated before journey, B1

The other type of awareness that can be quantified by the INFOChain experiment is the Awareness of Capability or the awareness of the participant's own limitations (Pre-Journey compared to the Deviation), obtained by the difference between the curves regions (**SPre** and **SDev**). Table 7.18 shows the Awareness of Capability disaggregated by stage of the B1 Journey Chain.

Table 7.18 – Awareness of Capability per Stage

B1 Stages	ICp:Ecr	Real Info	AWARENESS of CAPABILITY
	Deviations	Pre-Journey	
Walk O	2.00	0.20	10.00%
Wait	3.00	1.00	33.33%
Get On	3.00	2.00	66.67%
Interchange	5.00	2.00	40.00%
Riding	3.00	0.58	19.33%
Get Off	2.00	2.00	100.00%
Walk D	3.00	2.00	66.67%
TOTAL	21.00	9.78	46.57%

Figure 7.6 is the visual representation of the awareness of the individual's capability, the difference between Pre-Journey information and Deviation information.

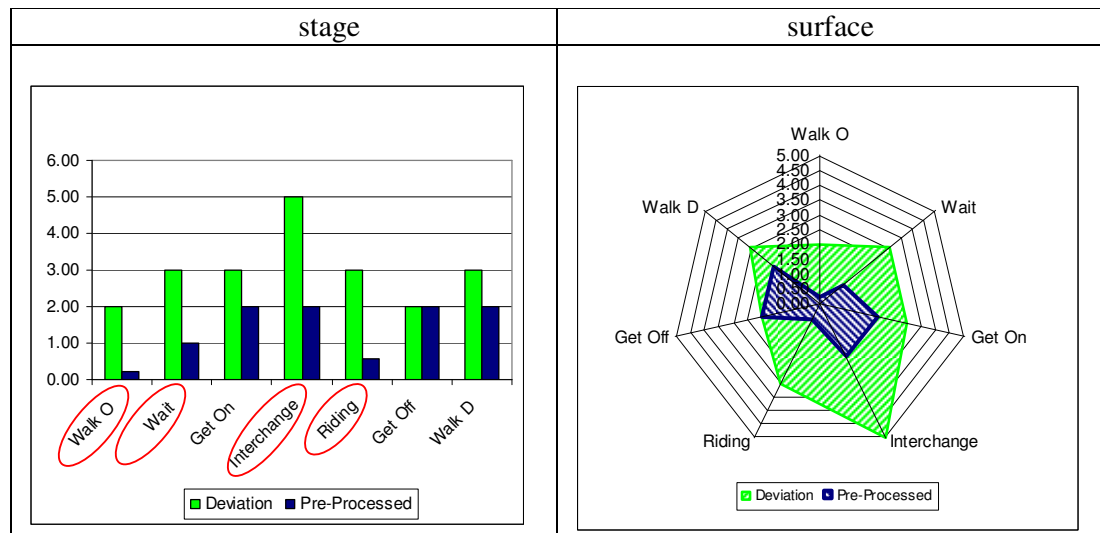


Figure 7.6 – Awareness of Individual Capabilities, B1

Getting off was the only stage fully covered according to the Capability Awareness concept. All the other stages can be considered neglected by participant.

Figure 7.7 illustrates, in more detail, the relation between the information manipulated before, in and after the journey – the curves and the surfaces illustrations.

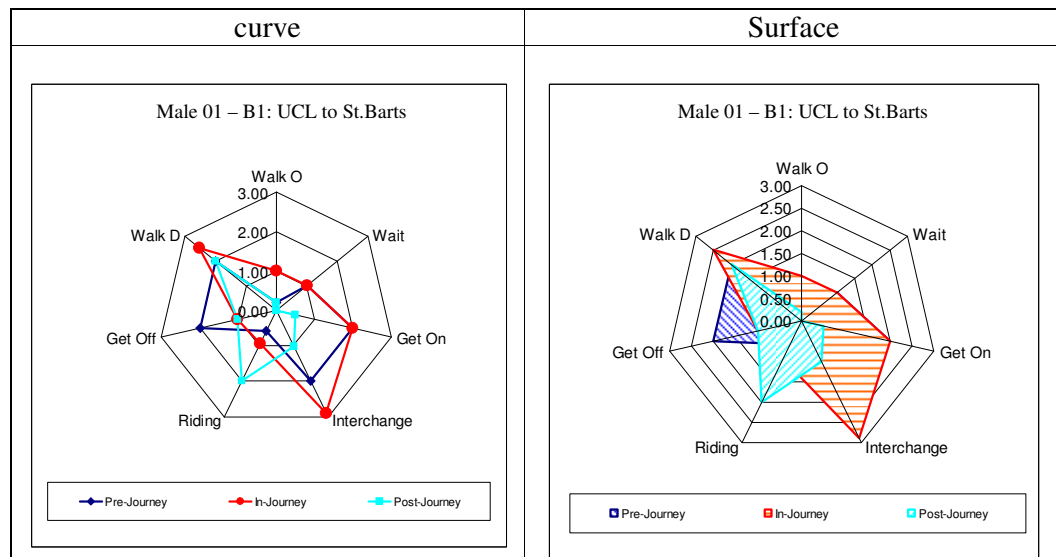


Figure 7.7 – The Pre-Journey, In-journey, Post-Journey Information Curves, B1

The ‘Pre-Journey’ (**SPre**) and the ‘In-Journey’ (**SinJ**) information are not synchronised. The ‘getting off’ stages used less information than what was processed and the ‘interchange’ and the ‘walking to destination’ ‘consumed’ more than was processed. Finally, the ‘Post- Journey’ information processed (**SPos**) to be transferred to a third

person apparently illustrates worries about some stages ('riding' and 'walking to destination'), suggesting that these stages have impacted on the participant's journey impression. It is worth commenting that these are the stages where the environmental cues (e.g.: landmarks) could be mostly used, suggesting that they are the unpredictable stages (because he has not chosen information to deliver such knowledge) and therefore the stages that could make the journey more difficult in this participant's opinion.

The fact that not enough information to deal with the real environment was apparently processed (as far as the tests applied could show) to complete some stages along the journey can indicate three situations:

- i. The participant does not need to formally represent it because he/she already has previous information to deal with the subtask;
- ii. The participant needs to represent it, but could not find the information to match the need;
 - a. In consequence:
 - i. He/she extracts information from the environment's clues
(difficult for visual impaired and cognitive impaired people)
 - ii. He/she extracts information from a third person (difficult for hearing impaired and cognitive impaired people)
- iii. The participant does not know he/she needs to represent it.
- iv. The information is neither available nor it can be captured at this point in the process.

The exact identification of which of these situations pertains is difficult because even if deeper interviews were conducted, the participant might not demonstrate knowledge or any need for specific information. Previous studies about an individual's need for transport mobility and accessibility issues have found that it is very hard to define the need for something that they are not used to or when a person is not conscious that they could have or that they have the right to have or would like to have a particular piece of information because the individual had never been experienced the need before, (See Lynas (1997), Brown (1996) for more details). It is even worse when the service level of the transport system is low and the education level of users is poor, as is often the case in Latin America. More evidence about reasons for information neglect and in which situation it can happen will be shown later in this section.

In general, the journey should have been planned better than it was. The awareness of information is regular (57%) but the awareness of individual's capability is worse (47%). Table 7.19 illustrates the stage with problems according to different indicators of awareness. The faulty stages are stages where the process of information is below 50%, a weak process according to Table 7.16.

Table 7.19 - Faulty stages revealed by Indicators

Indicators	Walk O	Wait	Get On	Interch.	Ride	Get Off	Walk D
Awareness of Information	X				X		
Awareness of Capability	X	X		X	X		

The former analysis concentrates on the shape of the curves. Some evidence during the execution of the journey are now added to enrich the analysis. Table 7.20 lists some verbal statements declared during the baseline phase. The arguments were grouped according to the methodology of analysis and interpretation of qualitative data, as suggested by Dey (1993) and Kitchin and Tate (2000), which reinforces description and classification of data and interconnectivity of concepts.

Table 7.20 - Coping Strategies, Feelings and Perceptions

Stage	Coping strategy	Feelings/Perceptions
Plan	Before: "Because of time I would go for taxi or tube. If I have time I would walk. It is an hour walking." After: "I have change a bit what I have planned"	Before: "Buses are very unreliable." After: "I have change a bit what I have planned"
Walk to bus stop		"Walking distance of interchange was longer than I was expecting."
Wait		
Get on		
Ride		"Riding was slower than I thought it would be. More bus stops than I thought."
Getting off	# "Knowing where to get off on the second bus"	"I didn't see Giltspur Street in time to get off at a closer bus stop."
Walk to hospital		"I think that is the hospital ... I don't know where it is. I am lost" "The exact place of the hospital was a bit further than I thought."
# Difficulties and 🙋 Help		

Figure 7.8 illustrates the reported levels of attention and anxiety during the execution of the journey. According to the individual self reported levels of attention and analysis, the 'riding' stage was clearly the most demanding in terms of attention and also the one

that has caused the higher levels of anxiety (actually, the maximum level 10). However, although the differences between ‘getting off’ and ‘riding’ stages were explicit from the method of analysis applied, the participant might not differentiate it, at this stage, because this is the first contact with the experiment procedures. The difficulties presented in Table 7.20 can indicate a need for prudence when using self-reported answers. Corrections (grey dotted lines) were manually made in the picture to indicate possible alternatives behaviours. The risk curve (risk perception test, Chapter 5, Section 5.4.11) and the declared difficulties along the journey (subjective evaluation of the journey, after journey assessment) were added to the graphic to enrich the analysis of subjective values. The Risk scale [1-5] was converted to [1-10] for comparisons.

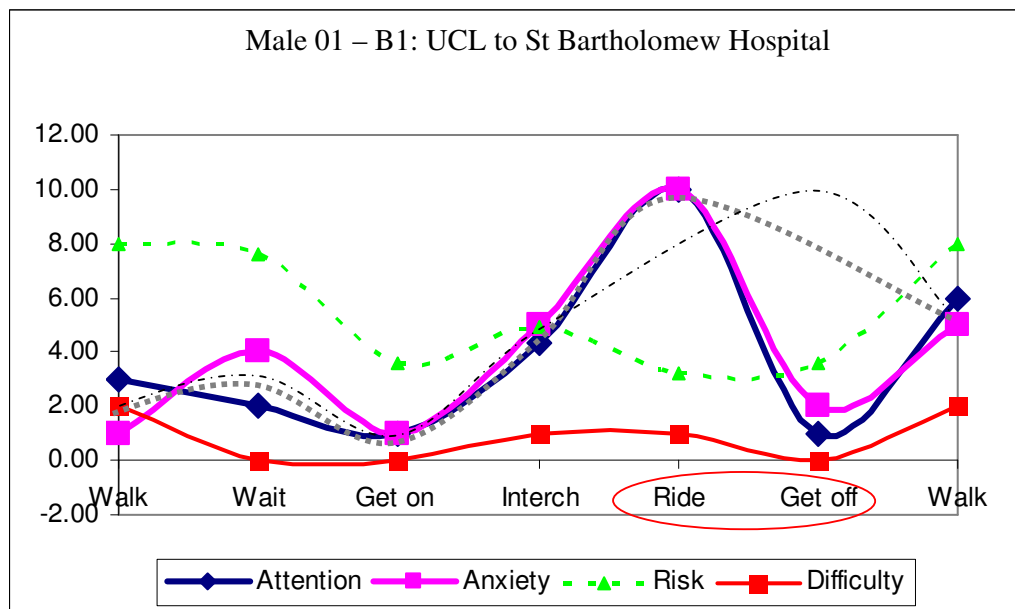


Figure 7.8 – Self Reported Attention and Anxiety Levels, B1

From the quantitative measures of awareness and the qualitative analysis of data it can be said that the apparent neglect of ‘walking to bus stop’ stage was, mainly, due to the high level of knowledge about the origin area. ‘Interchange’, ‘riding’ and ‘walking to hospital’ stages were not as prepared as they should have been, even though the information investigated (Area Bus Guide) would have provided sufficient information. Table 7.20 supports this conclusion. Figure 7.4 and 7.7 brought some evidence about the use of information extracted from the environment during these two stages. Landmark references, a route diagram inside the bus and a complete drawn map from the bus stop to hospital (AI-type developed for this experiment) are some examples of information that could alleviate the high levels of anxiety felt on these stages.

In terms of time, a constraint was imposed (40 minutes) to produce the plan and execute the journey at the beginning of the plan exercise. When reviewing time issues, the participant believed that, 60 minutes would be required just to do the journey. The actual time taken to execute the journey was 30 minutes. The appointment was fixed for 16:05; he arrived at 15:55. He declared (question # 27, Table 6.2) that he arrived at the hospital on time without problems although he mentioned that he was lost in the final stage of the journey. For the experimental control, the interviewer judgement was that participant arrived at the hospital on time for the appointment, despite some problems.

The next section presents results of the second real journey exercise (B2), the presentation is concentrated in the shape and interpretation of the curves/surfaces of the information.

7.3.1.3 Results from Real Journey 2: UCL to Marie Curie Centre

A brief description of the journeys was introduced in Section 7.2. Table 7.21 illustrates the type of information selected to construct the plan: Journey Planner, accessible and digital official information type provided by London Transport.

Table 7.21 – Information gathered to initiate B2

REAL JOURNEY B2 Information Used to Compose PLAN: Journey Planner							
Stage	#	Content of Information		Potential	Selected	Processed	Selected + Processed
Walk O	1	Path identification Information	E	1	0.80	1.00	1.00
	2	Distance (time) to walk	T	1	1.00		1.00
Wait	9	Bus Stop Identification	E	1	1.00	1.00	1.00
	13	Waiting time	T	1	1.00	1.00	1.00
Get On	15	Bus Service Identification	E	1	1.00	1.00	1.00
	16	Bus Type	AI	1			
	17	Cost	E	1		1.00	1.00
Ride	24	Landmarks References	E	1			
	25	Direction	E	1	1.00	0.49	1.00
	26	Distance (time or km)	T	1	1.00	1.00	1.00
Get Off	28	Landmarks References	AI	1	1.00	1.00	1.00
	29	Bus Stop Identification	E	1		1.00	1.00
Walk D	32	Path identification	E	1	1.00	1.00	1.00
	34	Distance to walk	T	1	1.00		1.00
	40	Target (Hospital) identification	E	1	1.00	1.00	1.00
TOTAL				15.00	10.80	10.49	13.00
Total E				9.00	5.80	7.49	8.00
Total T				4.00	4.00	2.00	4.00
Total AI				2.00	1.00	1.00	1.00

From the 15 types of attributes that could potentially be used, 10.80 were formalised in the plan representation (72%). The total of information extracted (selected and processed: 13) represents 87% of the set of information on offer, which is considered to be a good level (refer to Table 7.15) of information processing (and higher than B1). Comparison between B1 and B2 phases are presented at the end of this section.

Table 7.22 illustrates the Awareness of Information disaggregated by stage of the B2 Journey Chain. Figure 7.9 is the visual representation of this.

Table 7.22 – Awareness of Information per Stage

B2 Stages	Real Info Investigated	Information Processed	AWARENESS Of INFORMATION
	Potential	Pre-Journey	
Walk O	2.00	2.00	100.00%
Wait	2.00	2.00	100.00%
Get On	3.00	2.00	66.67%
Riding	3.00	2.00	66.67%
Get Off	2.00	2.00	100.00%
Walk D	3.00	3.00	100.00%
TOTAL	15.00	13.00	86.67%

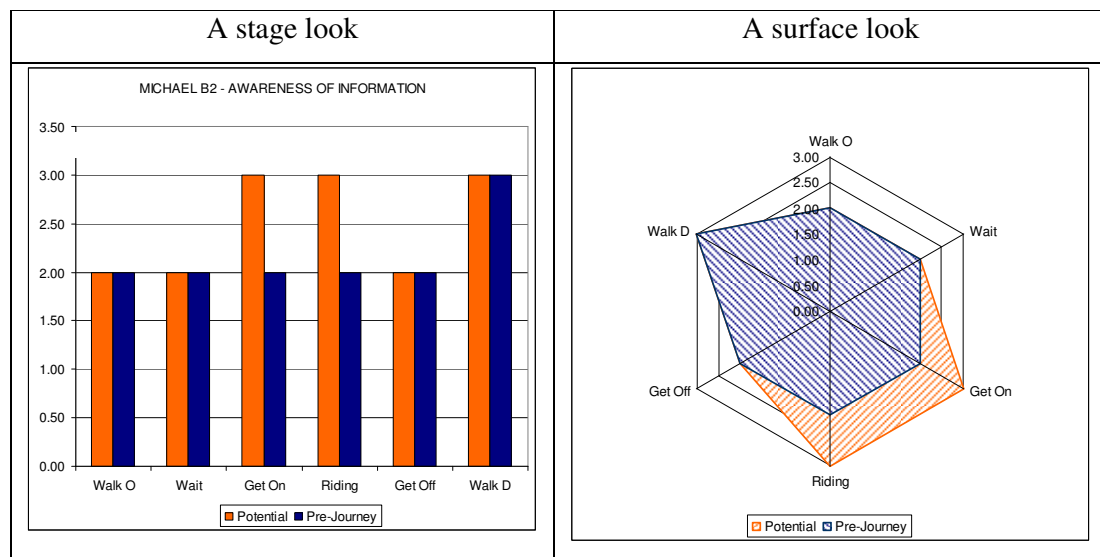


Figure 7.9 - Awareness of Information per stage, before journey, B2

Figure 7.9 shows that in general most of the stages are covered by the piece of information (Journey Planner) which was selected to compose the plan for this journey, 'get on' and 'riding' being the only two stages in which the information available was not fully consumed.

Figure 7.10 illustrates all curves which represent the individual's use of information (selection, processing and use) for this specific journey. The figure shows that the area of information investigated (**SPot**) does not cover all the stages recommended by the Deviation curve (**SDev**) but it does fully cover the minimum amount of information needed to compose the plan. As a whole, it can be said that because the 'Potential' information investigated is not enough to deal with the set of individual capabilities, the participant might find difficulties, particularly, along the final stages of his journey.

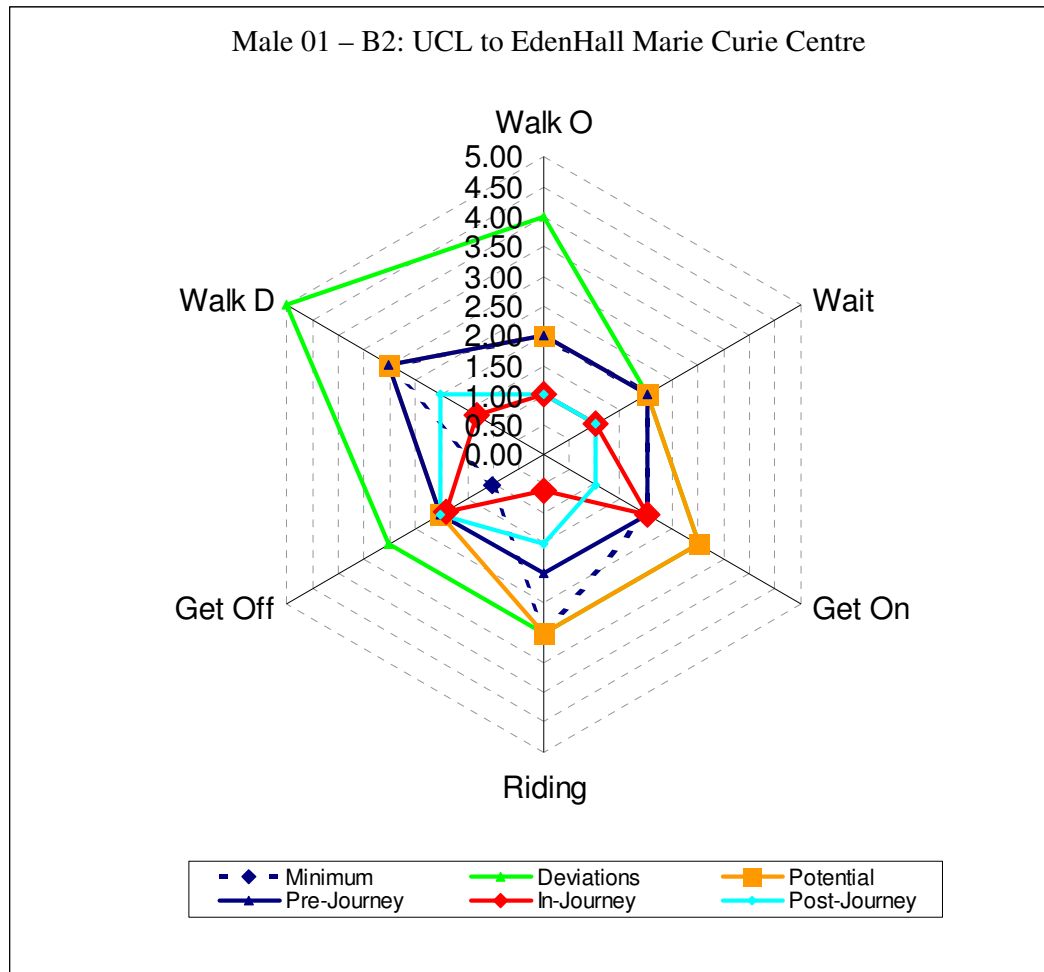


Figure 7.10 – Different Types of Information Manipulation, B2

Figure 7.11 illustrates, in more detail, the relation between the information manipulated before journey – the curves and the surfaces illustrations. It can be perceived that participant has investigated information to fully cover his deviations along the 'wait', 'get on' and 'riding' stages. However the last part of the journey ('getting off' and 'walk to hospital') should have been considered in more detail taking into account his declared lack of knowledge about the destination area and the shape of the deviation curve. The

participant should have explored in more detail the information not available in Journey Planner but provided by the AI-type produced for the experiment, with which he was familiarised and which he judged to be of great value (during the treatment phase of the experiment). The neglect in relation to the walk to bus stop stage can be explained by his high declared knowledge of the area around the origin.

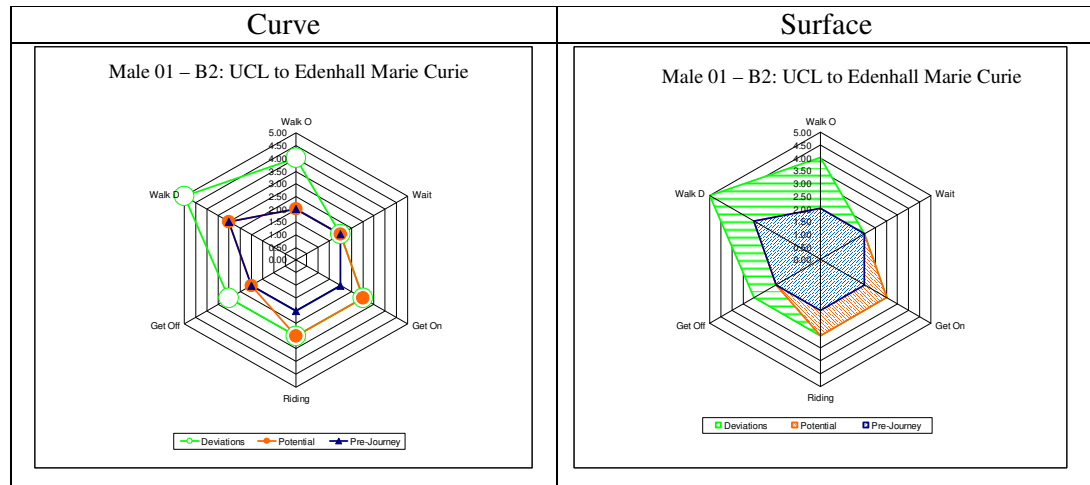


Figure 7.11 – Information manipulated before journey, B2

Table 7.23 shows the Awareness of Capability disaggregated by stages of the B1 Journey Chain and Figure 7.12, the visual representation of the awareness of the individual's capability. The 'Wait' stage was the only one to be fully covered according to the Capability Awareness concept. All the other stages can be considered partially neglected by participant.

Table 7.23 – Awareness of Capability per Stage

B2 Stages	ICp:Ecr	Real Info Processed	AWARENESS of CAPABILITY
	Deviations	Pre-Journey	
Walk O	4.00	2.00	50.00%
Wait	2.00	2.00	100.00%
Get On	3.00	2.00	66.67%
Riding	3.00	2.00	66.67%
Get Off	3.00	2.00	66.67%
Walk D	5.00	3.00	60.00%
TOTAL	20.00	13.00	65.00%

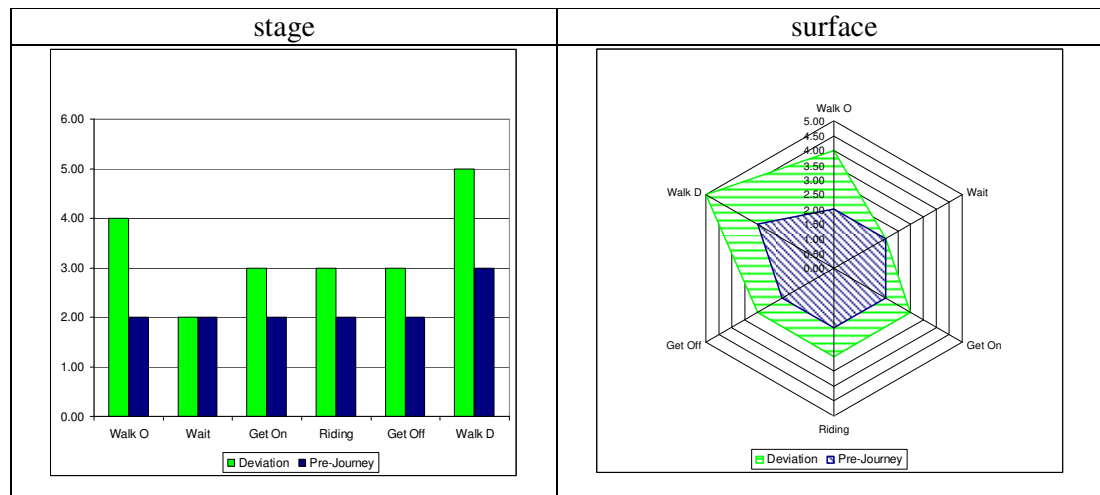


Figure 7.12 – Awareness of Individual Capabilities, B2

Figure 7.13 illustrates, in more detail, the relation between the information manipulated before, in and after the journey – the curves and the surfaces illustrations.

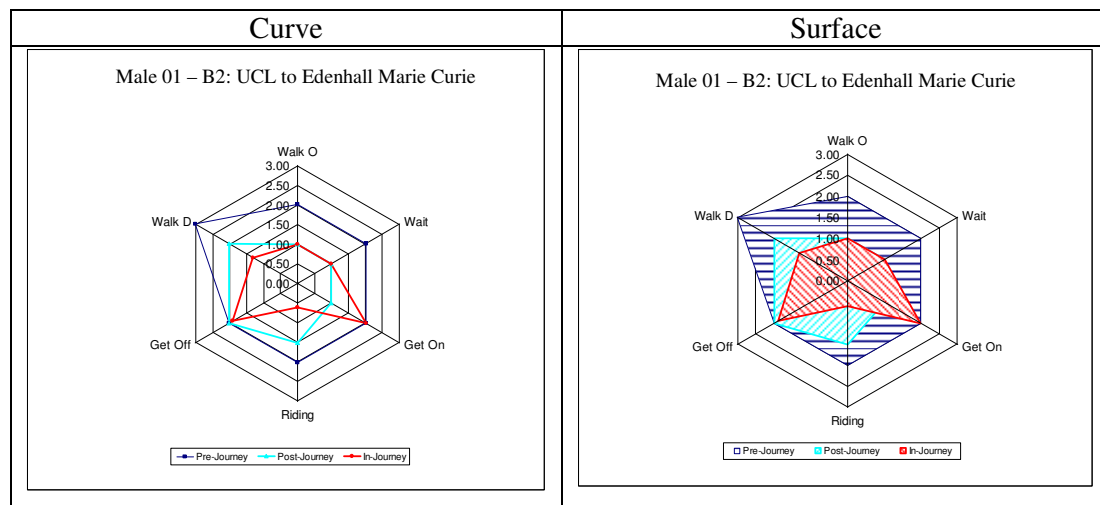


Figure 7.13 – The Pre-Journey, In-journey, Post-Journey Information Curves, B2

The ‘In-Journey’ curve is inside the ‘Pre-Journey’ curve meaning that enough information was processed, more than was used (as far as the experiment could extract).

In general terms, the journey was reasonably planned. The awareness of information was high (87%) and the awareness of the individual’s capability has improved (68%, when compared with baseline 1). Table 7.24 illustrates the stages with problems according to different indicators.

Table 7.24 - Faulty stages revealed by Indicators

Indicators	Walk O	Wait	Get On	Ride	Get Off	Walk D
Awareness of Information						
Awareness of Capability	X					

During the execution of the journey, unfortunately, imprecise information from Journey Planner induced an erratic navigation at the destination area which affected the participant's behaviour and the declared anxiety levels, as can be demonstrated by Table 7.25 and Figure 7.14.

Table 7.25 - Coping Strategies, Feelings and Perceptions

Stage	Coping strategy	Feelings/Perceptions
Plan	Ask a person.	# Finding the centre, I don't know the area.
Walk to bus stop		I started all right, although I thought the bus stop was at the south side of Woburn St and not North.
Wait		
Get on		Bus 168 was there.
Ride		
Getting off	I didn't see Rosslyn Hill but I saw Bus Stop G and got off.	I didn't see Rosslyn Hill but I saw Bus Stop G and got off.
Walk to hospital	# "Then problems start: There was no sign of Webburn St, so I asked one person but he didn't know. 🙅 I went to News Agent and decided to look for A to Z. It indicated that I was right. I overestimated (over trust) Journey Planner."	"I am lost". # The last part was difficulty. 🙅 I should have looked at A to Z while I was planning.
# Difficulties and 🙅 Help		

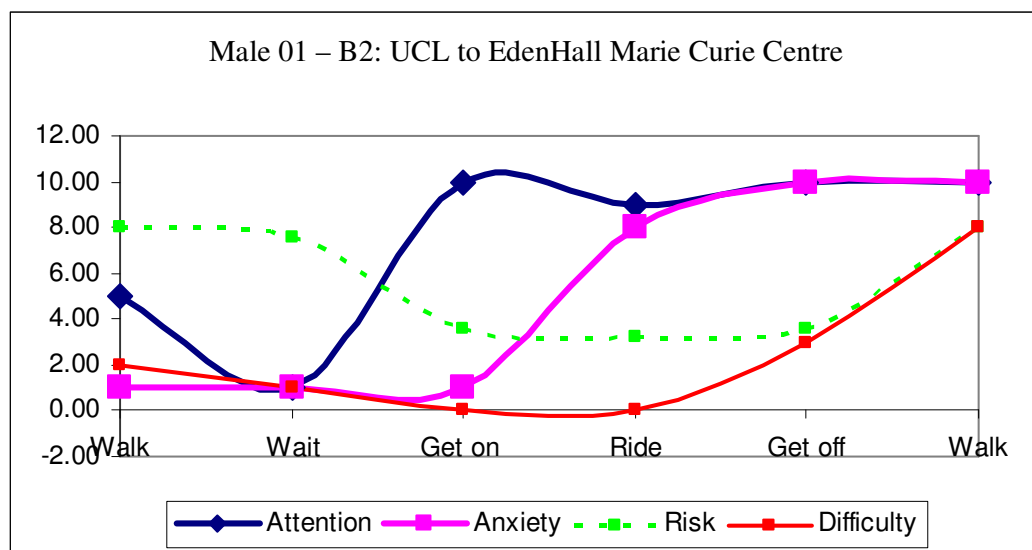


Figure 7.14 – Self Reported Attention and Anxiety Levels, plus perceived risk and difficulties, B2

From quantitative and qualitative measures it can be said that when undertaking the second journey this participant is more conscious about the information he used and about his limitations than he was for the first journey. He has accumulated more information about the 'walking to hospital' stage - although not enough to avoid confusion (see Table 7.25). The stress felt during this stage could have been avoided if he had made use of an AI-type piece of information 'Complete drawing from bus stop to hospital' (which he had judged to be of great value, during treatment phase).

It seems that although AI-type is valuable it is either not easy to be included by the participant or it is necessary to have more time to train the participant to make use of what is available. Even when the problem was realised, the alternative was to use traditional forms of information, such as the A to Z map (as can be seen by Table 7.21). However the participant was open to try Journey Planner which could be an indication that he is willing and able to change the information media and format even though the content was the same.

In terms of time, similarly to the first journey, a time constraint was imposed at the beginning of the plan exercise (40 minutes). When reviewing time issues, the participant requested 47 minutes just to do the journey. The actual time taken to execute the journey was 35 minutes. The appointment was fixed for 15:30, he arrived at 15:25. The participant evaluated that he arrived at the hospital on time despite some problem. Interviewer report agrees with participant's evaluation: He arrived at the hospital on time but not without problems as he got lost at the destination area and demonstrated high levels of anxiety as a result. He made a great effort to arrive at the destination on time, he ran and got agitated.

7.3.1.4 Differences between Male_01's Baseline 1 and Baseline 2 Behaviours

At this stage, it is useful to present a comparison between results obtained in Baseline 1 and Baseline 2.

Table 7.26 and Figures 7.4 and 7.10 show the main results from B1 and B2. In terms of the potential content of information investigated no huge difference was observed (Table 7.26) but the process (Pre-Journey) was different. Differences can be observed in terms of pattern: for B1 phase, 90% of information investigated concentrated on

answering essential questions, whereas for B2 there is more information related to time issues. The level of AI-type was basically the same.

Table 7.26 – Main Differences from Information Investigated and Pre-Journey-Processed

	Potential				Pre-Journey Processed			
	B1	B1(%)	B2	B2 (%)	B1	B1(%)	B2	B2 (%)
TOTAL*	17.00	-	15.00	-	9.78	-	13.00	-
Total E	11.00	65%	9.00	60%	8.78	90%	8.00	62%
Total T	4.00	24%	4.00	27%	0.00	0%	4.00	31%
Total AI	2.00	12%	2.00	13%	1.00	10%	1.00	8%

* Numbers summarised information presented on Tables 7.12 and 7.17 (Information Gathered to Initiate Journey)

Table 7.27 illustrates the evolution of differences between Information Awareness and Awareness of Capability. Some improvements in performance can be observed in most of the stages of the Journey Chain for awareness of information. This could be an evidence of improvement in the planning strategy but it is not conclusive. For example, if the format of Journey Planner contributed to the problem-solving strategy adopted, the participant could become more familiar with the information type, or he could be influenced by the knowledge acquired during the experiment (e.g.: after producing 5 journey plans the participant might have become able to anticipate what would be a “good plan”.) Another important factor to be considered was the knowledge of the area declared: in B1, the knowledge was high [nine]; in be B2: nil. This could suggest that the participant had less knowledge and thus realised that he needed a better plan. Awareness of capability is more unsettled.

Table 7.27 – Differences in Awareness

Journey Stages	AWARENESS of INFORMATION			AWARENESS of CAPABILITY		
	B1	B2	$\Delta 1$	B1	B2	$\Delta 2$
Walk O	10.00%	100.00%	↑	10.00%	50.00%	↑
Wait	50.00%	100.00%	↑	33.33%	100.00%	↑
Get On	66.67%	66.67%	=	100.00%	66.67%	↓
Interchange	100.00%	-		40.00%	-	
Riding	19.33%	66.67%	↑	19.33%	66.67%	↑
Get Off	100.00%	100.00%	=	100.00%	66.67%	↓
Walk D	66.67%	100.00%	↑	66.67%	60.00%	≈
TOTAL	57.53%	86.67%	↑	46.57%	65.00%	↑

(≈: when the Δ is around 10 points)

7.3.1.5 Conclusions about Male-01 Case

In terms of information use, it could be said that an improvement was observed between experiments: B2 was better planned than B1 – the participant seemed to be more conscious of the journey and information chains. However, most of the areas covered in both phases, are below the Deviation Curve indicated by Capability Model (i.e.: that he chose less information than he should have in order to deal with his impairment and the demands of the environment), as illustrated in Figures 7.4 and 7.10. This suggests that the participant's strategies could be enhanced in relation to a better understanding of his own limitations and a better plan formulation in order to reduce anxieties and smooth the journey's obstacles.

In terms of performance (execution of journey), B2 journey was more difficult to be executed than B1 even though his plan improved.

In relation to the type of information selected to compose a plan, it can be concluded that Journey Planner was an easier way to absorb information for this participant but he could also extract the same content from traditional types of information. Faulty information can impact immensely on the participant's perception, can put the whole information systems in doubt and can damage the reliability of the bus system.

Concerning the usefulness of AI-type of information, it seems that although this participant has presented some impairments and weak competences, the absence of AI-type of information is not a barrier for him to complete the activity (plan and execute a journey by bus to arrive at medical appointment in time). Nevertheless he thinks it is important and this type of information can be instrumental in enhancing this participant's awareness of his own limitations and his anxiety reductions

However, the question about the trade-offs between anxiety level and accessible information needs further investigation, including objective measures to quantify anxiety in a real life experiment and cross-reference with the stages of the journey chain. One possibility is to instrument the participant, using a heart-rate monitor, EEG, and skin-conductance monitors, during planning and execution of the journey and compare objective data with subjective evaluation about anxiety pre and post journey. Another aspect of this new line of research would be to check if the levels of anxiety

registered in a real life experiments are in accordance with medical recommendations related to an acceptable general level of stress.

Sections 7.4.2 and 7.4.3 present the results obtained with the replication cases: Male_02 (73 years old) and Female_01 (71 years old). The subsequent analysis is presented in a short version emphasizing the differences between B1 and B2 and the main improvements during the experiment. A more interpretative approach is used to analyse the participant's coping strategies in the real environment condition. The analysis concentrates on:

- i. Type of information (E/T/AI) used to plan (written + oral versions) during the 5 journeys: the information pieces investigated and the type (E/T/AI) they cover.
- ii. Differences in the pattern of choice of information before and after the treatment;
- iii. Differences in capability awareness before and after the treatment;
- iv. Relation between attention, anxiety and difficulties during the journey and
- v. Success or Failure in achieving the task proposed by the experiment.

7.3.2 Male-02 Case

7.3.2.1 Selection of information to compose the plans

Table 7.28 lists the information pieces used to compose the plan for the five journey exercises.

Table 7.28 – List of Information Investigated to Plan

Experiment Phase	Time (min)	Degree Of Difficulty to Plan	Information Selected to Plan	Plan Quality (subjective opinion)
Real Journey 1 (B1) (Interchange)	8	4 [easy]	i. Central Area Bus Guide	6 [moderate]
Virtual Journey 1	7	2 [easy]	i. Central Area Bus Guide ii. North West Bus Guide	8 [good]
Virtual Journey 2	22	3 [easy]	i. Easy Ride London ii. A to Z iii. Central Area Bus Guide	7 [moderate]
Virtual Journey 3	8	3 [easy]	i. A to Z ii. Area Bus Guide	10 [very good]
Real Journey 2 (B2) (Interchange)	8	2 [easy]	i. Easy to Ride London ii. Central Area Bus Guide iii. North West Bus Guide	10 [very good]

As illustrated in Table 7.28 no changes in plan pattern were perceived: the participant has kept the choice to traditional forms of information: the A to Z and the Area Bus Guide (same choices throughout experiment). In general, he was happy with the quality of the plan he did and he considered the planning task to be easy.

Figure 7.15 shows the potential amount of each type of information (E/T/AI) provided by the set of information pieces selected by participant during the experiment. The pattern of the actual selection of E-type, T-type and AI_type information was kept almost the same throughout experiment. No evidence of selection of information to cover AI-type attributes was demonstrated.

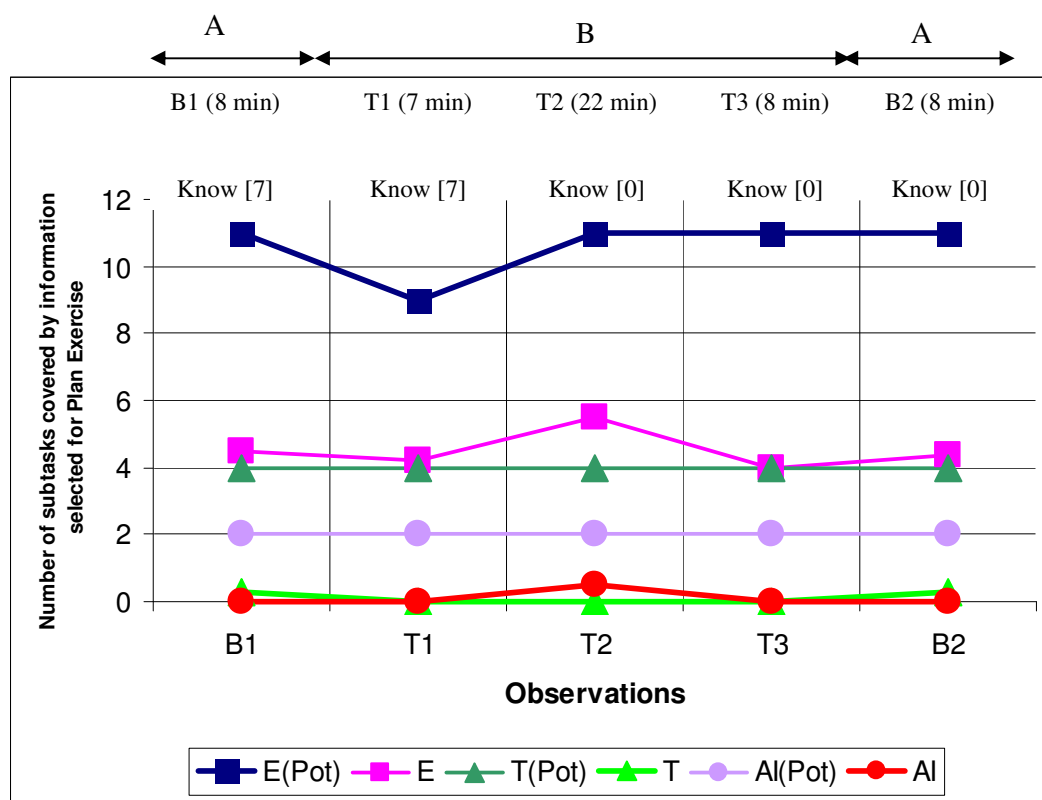


Figure 7.15 – Single Case Results: (Potential & Selected) Information by Male-02

Table 7.29 reveals some details from the treatment phase of experiment.

Table 7.29 – Most Important Information selected during Treatment Phase

Journey Stage	T1		T2	
	Most important Information	Risk	Most important Information	Risk
Walking	(AI) Complete path drawing to bus stop [10]	-	(AI) Landmark picture sequence [10]	-
Waiting	Route (schematic) [10]	If I board the right bus there is no risk at all	(AI) Where to catch your bus[10]	-

Getting on	(AI) Nearest accessible bus stop indication [10]	Possibility of missing step	(AI) Nearest accessible bus stop indication [10]	-
Riding	(AI) Route with landmarks [10]	Missing destination stop	(AI) Landmarks picture sequence [10]	-
Getting off	(AI) Nearest accessible bus stop indication [10]	Tripping on kerb	(AI) Nearest accessible bus stop indication [10]	-
Walking	(AI) Complete path drawing to the Hospital [10]	-	(AI) Complete Path drawing to the Hospital [10]	-
T3 (Game)	Information selected: i. A to Z (1T) ii. Area Bus Guide Map (1T) Total tokens selected: 2T		Information bought: i. Area Bus Guide Map (1T) Total tokens selected: 1T	

Table 7.29 shows that the participant has considered the use of AI-type of information in different stages of the journey and he has judged them to be useful. In terms of risk he could identify a few types but he gave up trying to identify risks in the second journey treatment. Even so, the usefulness of AI-type information was only apparent when analysed by stage and, as illustrated in Table 7.28, it was not transferred to the selection/process of information in the return to baseline condition (B2).

7.3.2.2 Differences between Male_02's Baseline 1 and Baseline 2 Behaviours

Table 7.30 shows main results of B1 and B2.

Table 7.30 – Main Differences: Information Investigated and Accumulated

	Potential				Pre-Journey			
	B1	B1(%)	B2	B2 (%)	B1	B1(%)	B2	B2 (%)
TOTAL	17.00	-	17.00	-	12.30	-	13.00	-
Total E	11.00	65%	11.00	65%	11.00	89%	10.00	77%
Total T	4.00	24%	4.00	24%	0.30	2%	2.00	15%
Total AI	2.00	12%	2.00	12%	1.00	8%	1.00	8%

There is no difference in terms of the content of information investigated between B1 and B2. The choice of information pieces is absolutely the same, however, it can be observed, that some differences appeared in terms of patterns: in B1, 89% of information accumulated was concentrated on being able to answer Essential questions, in B2 there is more information related to Time issues. The level of AI-type was kept the same.

Table 7.31 illustrates the evolution of differences between Information Awareness and Capability Awareness.

Table 7.31 – Differences of Capability Awareness

Journey Stages	AWARENESS of INFORMATION			AWARENESS of CAPABILITY		
	B1	B2	$\Delta 1$	B1	B2	$\Delta 2$
Walk O	50.00%	25.00%	↓	50.00%	10.00%	↓
Wait	50.00%	100.00%	↑	33.33%	50.00%	↑
Get On	66.67%	66.67%	=	100.00%	100.00%	=
Interchange	100.00%	75.00%	↓	40.00%	30.00%	≈
Riding	66.67%	83.33%	↑	66.67%	83.33%	↑
Get Off	100.00%	100.00%	=	100.00%	66.67%	↓
Walk D	76.67%	83.33%	↑	57.50%	50.00%	≈
TOTAL	72.35%	76.47%	≈	58.57%	48.15%	≈

(≈: when the Δ is around 10 points)

There are slight differences between the baselines with a tendency towards a reduction of Capability Awareness in B2.

In terms of the self reported attention and anxiety levels, the risk perception and the declared difficulties, Figures 7.16 and 7.17 illustrate the behaviours in B1 and B2. In both cases the level of attention was very high throughout the journey. The participant declared he had no difficulties in executing the journey B1 and the levels of anxiety were low (lower than 4) throughout the journey.

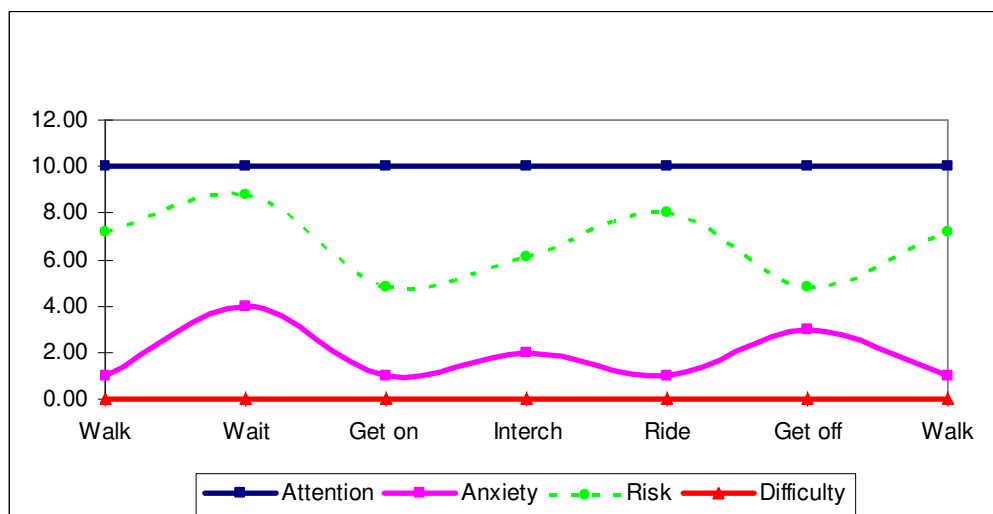


Figure 7.16 – Self Reported Attention and Anxiety Levels, plus perceived risk and difficulties in B1

In terms of performance, B2 was a bit more difficult to execute, mainly during walking stages but the levels of anxiety raised considerably, when compared with B1.

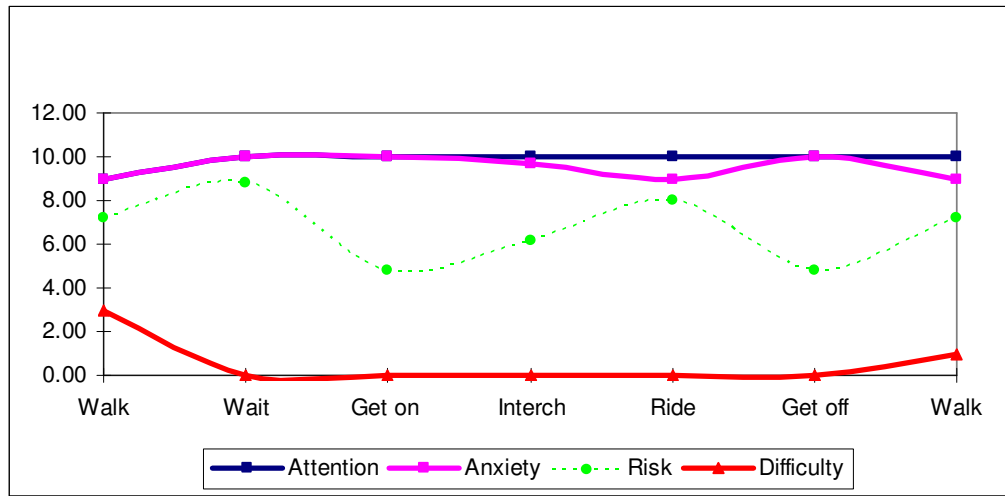


Figure 7.17 - Self Reported Attention and Anxiety Levels, plus perceived risk and difficulties in B2

7.3.2.3. Conclusions about Male-02's Case

Analysis of the information use during B1, Figure 7.18, illustrates that the participant's output-curves are below the **Deviation** curve recommendations (except the 'get on' stage in potential curve). In relation to information processed before journey (**Pre-Journey**) he did not take full advantage of the chosen information (**Potential**) and at interchange it did not cover even the minimum recommended.

In terms of experimental control, the participant arrived at the destination on time for the appointment, without problems. His report about the journey revealed that he neglected to look for alternative buses that would go to the same destination but realised in time, looking for information at bus stop, that he could slightly change his plan.

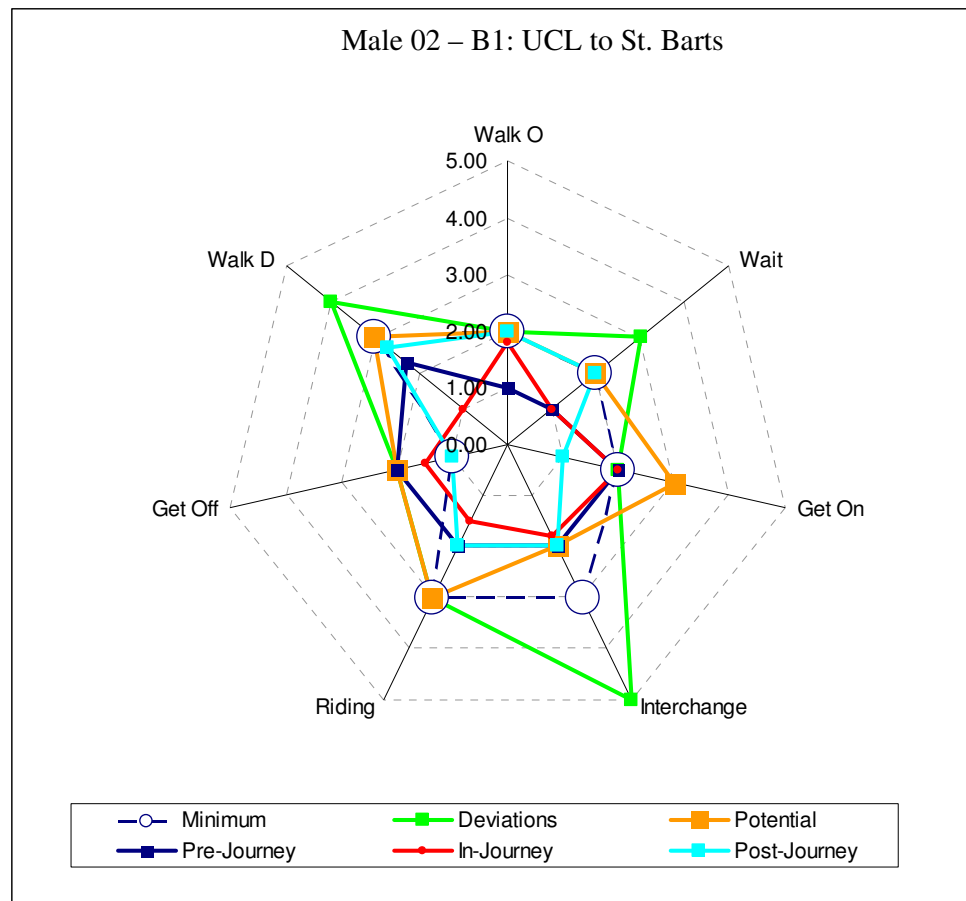


Figure 7.18 – Information Chain Dimensions B1

In terms of information use, Figure 7.19 illustrates that, during B2, the participant output-curves are also below the **Deviations** curve (exception: the ‘get on’ stage in potential curve). In relation to the information processed before the journey (**Pre-Journey**) he, again, did not take full advantage of the chosen information (**Potential**) and at interchange it did not cover even the minimum recommended. In fact the pattern of Potential curve was transferred for B2.

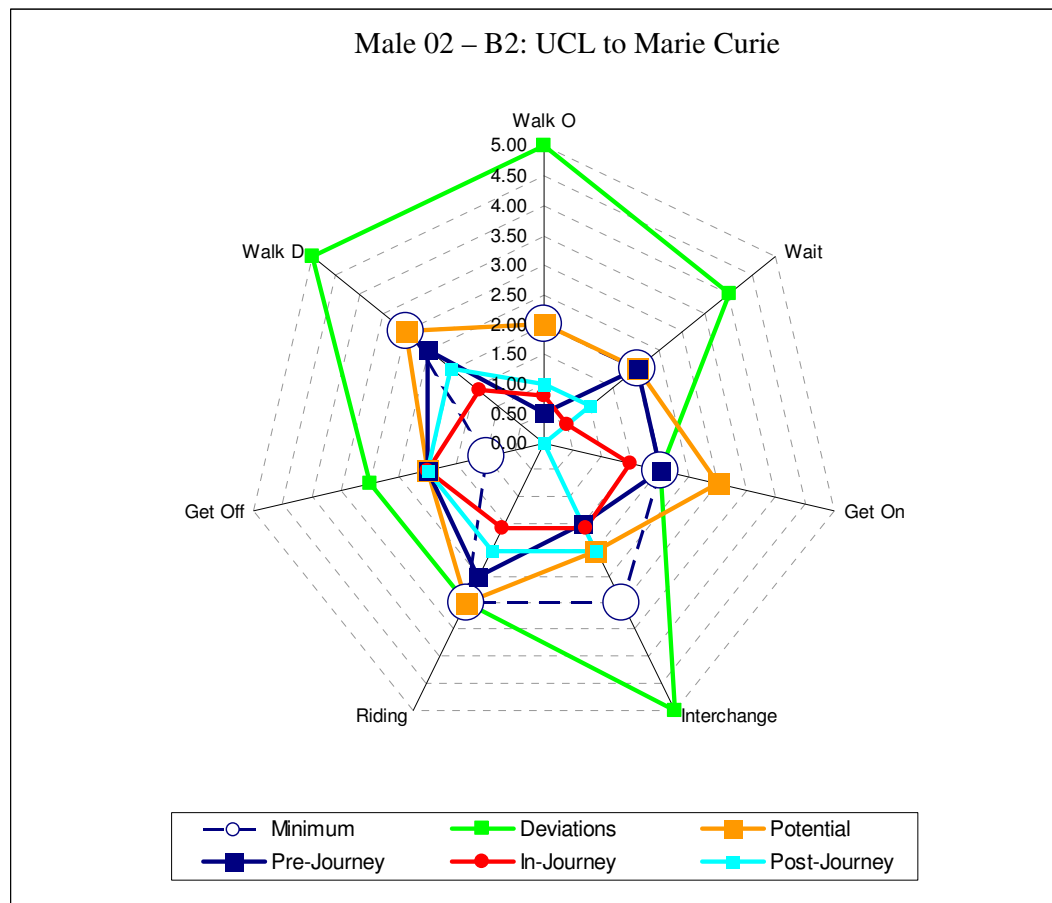


Figure 7.19 – Information Chain Dimensions B2

In terms of performance (execution of journey) B2 was more difficult to be executed than B1. It seems that the participant counts heavily on supportive information throughout the journey chain (e.g.: orientation signs; street name with post code signs). His high level of experience in using Public Transport and the third-person dependence he allows, reinforces the idea that this participant does not seem to have a problem in executing the tasks of the experiment, at least not at the practical level, according to his individual strategy.

According to the experiment criteria, the participant has arrived in time for the appointment, despite some problems (that he was luckily to sort out during the real journey, asking around).

However, from the economic point of view (minimum cost and time) his choices are neither the best options nor the easiest options. For more than one journey-exercise he used popular underground stations as references (e.g.: King's Cross, Oxford Circus) to

navigate; his plans are very rudimentary and the effort to obtain information before the starting journey is minimum, meaning that he tends toward the minimum. (Typical behaviour already underlined by other researchers (Lyons, 2002)).

A greater problem can be observed in another area. If the levels of anxiety he has declared are true [10 – high level, in all stages], one can think that using a bus system for this participant is a hard task. Another possibility is that he is not conscious about his anxiety and has overestimated it. Investigation towards anxiety and metacognition development would appear to demand further research in the transport area.

Another aspect that can be raised with Male_02 case is the importance of the supportive information found in the real environment. Because of orientation signs; street names with postcode; efficient timetables and diagram networks found in the London environment, this participant can navigate in the city, even though he has a poor plan, with a certain degree of confidence despite the fact that his strategy has a price in the form of the high levels of anxiety.

Training sessions to show him the potential of each type of information piece reinforcing the advantage of bus system and specific sessions oriented to self-awareness limitations might improve his plan strategy and might reduce his level of anxiety.

7.3.3. Female-01 Case

7.3.3.1. Selection of Information to compose plans

Table 7.32 illustrates the information investigated to compose the plan for each journey. The participant selected different forms of information in different phases (passive and interactive, printed, aural and digital). In general, the planning task was considered difficult in most of the phases of the experiment and her opinions about the plan quality are poor, but they are consistent: when the difficulty is high the plan is considered poor. During the first trial (Real Journey 1), the participant declared a lack of memory in joining all the different pieces of information together and a state of confusion was observed while planning journeys, although this gradually improved along the exercise.

Table 7.32 – List of Information Investigated to Plan

Experiment Phase	Time (min)	Degree Of Difficulty to Plan	Information Selected to Plan	Plan Quality (subjective opinion)
Real Journey 1 (B1) (No Interchange)	41	9 [difficult]	i. Easy to Ride ii. Hospital Webpage iii. (AI) Journey Planner iv. Central Area Bus Guide	1 [poor]
Virtual Journey 1 (Treatment)	10	3 [easy]	i. Area Bus Guide ii. (AI) Bus Service from Underground Station	8 [good]
Virtual Journey 2 (Treatment)	15	8 [difficult]	i. Telephone Directory ii. Area Bus Guide iii. (AI) Journey Planner	4 [poor]
Virtual Journey 3 (Monetary Concept)	28	10 [very difficult]	i. (AI) Journey Planner	0 [very poor]
Real Journey 2 (B2) (No Interchange)	21	7 [difficult]	i. A to Z ii. Easy to Ride iii. North West Bus Guide iv. Central Area Bus Guide ----- Chosen during token manipulation exercise v. (AI) Pictures of Bus Stop at Origin and at destination vi. (AI) Path from Bus Stop to Destination	2 [poor]

Figure 7.20 shows the potential amount of each type of information (E/T/AI) provided by the information pieces selected by the participant throughout the experiment. The pattern of selection of the E-type, T-type and AI-type information was variable. No evidence of improvement in the selection of the AI-type to compose the plan was demonstrated.

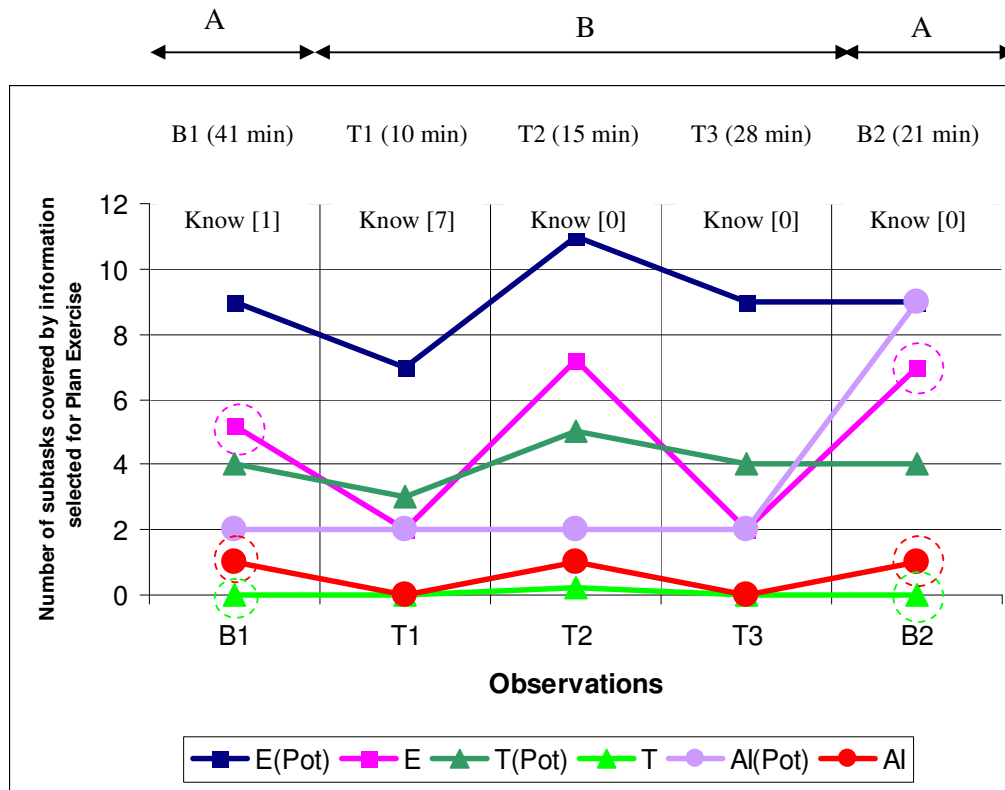


Figure 7.20 - Single Case Results: (Potential & Selected) Information by Female-01

Table 7.33 reveals some details from the treatment phase of experiment.

Table 7.33 – The Most Important Information selected during Treatment Phase

Stage	T1		T2	
	Most important Information	Risk	Most important Information	Risk
Walking	(AI) Complete path drawing to bus stop [10]	Traffic	(AI) Complete path drawing to bus stop [9]	Traffic
Waiting	(AI) Where to catch your bus [10]	Obstruction at bus stop	(AI) Where to catch your bus [10]	Poor visibility
Getting on	(AI) Where to catch your bus [10]	Obstruction at bus stop	(AI) Where to catch your bus [10]	Gaps
Riding	(AI) Route with landmarks [10]	Get loss Lack of info	(AI) Route with Landmarks [9]	Not knowing where I am
Getting off	(AI) How stop relates to hospital [8]	Tripping from road to kerb	(AI) Pictures of gaps [6]	Obstructed egress
Walking	(AI) Complete path drawing to the Hospital [9]	i. Uneven pavements ii. Lack of orientation signs iii. Lack of information about bus stop	(AI) Complete Path drawing to the Hospital [10]	Get lost
T3 (Game)	Information selected: i. A to Z (1T) ii. Area Bus Guide Map (1T) iii. (AI) Journey Planner (2T) Total tokens selected: 4T		Information bought: i. (AI) Journey Planner (2T) Total tokens given to participant: 2T	

When examined, stage by stage, this participant selected AI-type of information as the most useful pieces and she is able to list hazards (without being prompted). She also expressed the particular extra type of information she would like to have ('How stop relates to hospital' in 'getting off' stage', meaning quick and easy indication where the hospital is). In terms of the exercise objectives it can be said that this participant accepted information that she thought would deliver accessibility issues. However, this acceptability is only perceived in this condition, looking back to Table 7.32 the participant has not incorporated accessibility issues created by the experiment in her selection of information for the planning process, only incorporated AI-Type when developing the Token Manipulation exercise.

7.3.3.2. Differences between Female_01's Baseline 1 and Baseline 2 Behaviours

Table 7.34 shows the main results of B1 and B2. During Baseline 2, after treatment, the participant investigated and processed more information than she did in Baseline 1, with some emphasis on the acquisition of accessibility-type of information (AI).

Table 7.34 – Main Differences from Potential information investigated and Pre-Journey information accumulated

	Potential				Pre-journey			
	B1	B1(%)	B2	B2 (%)	B1	B1(%)	B2	B2 (%)
TOTAL	15.00	-	22.00	-	8.40	-	17.00	-
Total E	9.00	60%	9.00	41%	6.40	76%	9.00	53%
Total T	4.00	27%	4.00	18%	1.00	12%	3.00	18%
Total AI	2.00	13%	9.00	↑ 41%	1.00	12%	5.00	↑ 29%

Another positive point is related to the evolution of her Awareness of Capability. Table 7.35 illustrates differences between Information Awareness and Awareness of Capability

Table 7.35 – Differences of Capability Awareness

Journey Stages	AWARENESS of INFORMATION			AWARENESS of CAPABILITY		
	B1	B2	Δ1	B1	B2	Δ2
Walk O	10.00%	50.00%	↑	5.00%	25.00%	↑
Wait	10.00%	80.00%	↑	5.00%	100.00%	↑
Get On	66.67%	50.00%	↓	100.00%	100.00%	=
Riding	100.00%	100.00%	=	100.00%	100.00%	=
Get Off	50.00%	75.00%	↑	33.33%	100.00%	↑
Walk D	66.67%	100.00%	↑	50.00%	100.00%	↑
TOTAL	56.00%	77.27%	↑	42.00%	85.00%	↑

Considerable improvements in Awareness of Capability are observed. The negative alterations recorded for Information Awareness are not very large (< 25 points, in ‘get on’ stage).

In terms of the attention and anxiety levels, the risk perceived and the difficulties declared during the real execution of the journey, the Figures 7.21 and 7.22 illustrate the behaviours in B1 and B2. The level of attention varies between [6 to 10] during B1, except for the ‘wait’ stage, with peaks at the ‘riding’ stage. In B2, it varies from 5 to 10 with peaks at the ‘riding’ and the ‘walk to hospital’ stages. Both, the walking stage (‘walking to bus stop’ in B1 and ‘walking to hospital’ in B2) generated high levels of anxiety. The high level of ‘walking to the bus stop stage’ in B1 was due to intensive road works only found when executing the journey.

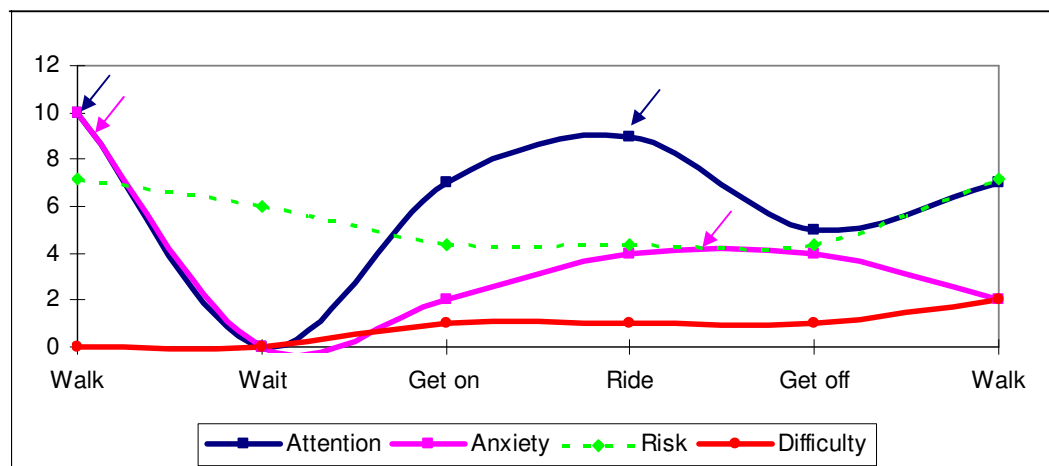


Figure 7.21 – Self Reported Attention and Anxiety Levels, plus perceived risk and difficulties in B1

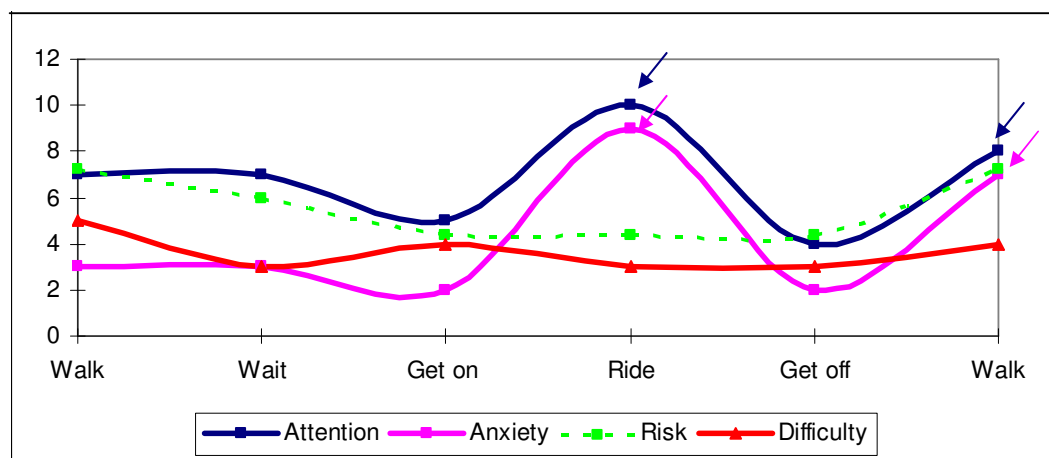


Figure 7.22 – Self Reported Attention and Anxiety Levels, plus perceived risk and difficulties in B2

In terms of performance, B2 was considered more difficult to execute than B1.

The high levels of anxiety in the ‘riding stage’ might have been caused by the complete lack of supportive information inside the bus, a fault of environment resources (more specifically, of the bus operators’ neglect). Remembering that the ‘iBus’ audio system was not installed during the experiment exercise. However this information is still faulty because the user needs to have the sequence of bus stop in mind in order to make sense of where s(he) is positioned along the route. A simple route map, inside the bus (e.g.: similar of London Underground schematic line diagram or similar of RATP route maps in Paris bus services) would help to connect the external information and include more disabled people.

7.3.3.3. Conclusions about Female_01’s Case

In terms of information use, Figure 7.23 illustrates that, during B1, most of the participant curves are inside the boundaries of the Deviation curve (**SDev**). The exception was the ‘get on’ stage in the **Potential** curve, meaning that this participant had the opportunity to have more information (than that recommended by Deviation). If she would process it is another issue. In relation to the information processed before the journey (**Pre-Journey**) it is observed that the ‘getting on’ and the ‘riding’ stages are exactly on the border of the deviation curve, meaning that, in theory, this participant gathered the information necessary to deal with the environment based on her individual capability. She also fully consumed what the information investigated could potentially deliver in the ‘riding’ stage. On the other hand the ‘walking to bus stop’ stage (where she acknowledges high levels of anxiety) was completely neglected by this participant. The **In-Journey** curve shows the difficulties found in the ‘getting off’, ‘walking to hospital’ and ‘walking to bus stop’ stages. Finally, the **Post-Journey** evaluation shows her worries about the ‘walking to hospital’ stage.

After the planning exercise she fixed the appointment for 14:30 (at 13:00), requiring 90 minutes to arrive at destination in time, but she said that she knew it could be done in roughly 50minutes“if nothing got wrong”.

In terms of the experiment control, she arrived in time without problems in B1. In reality, the journey was executed without major problems at the beginning and with assistance of the driver who she asked for help when she boarded the bus.

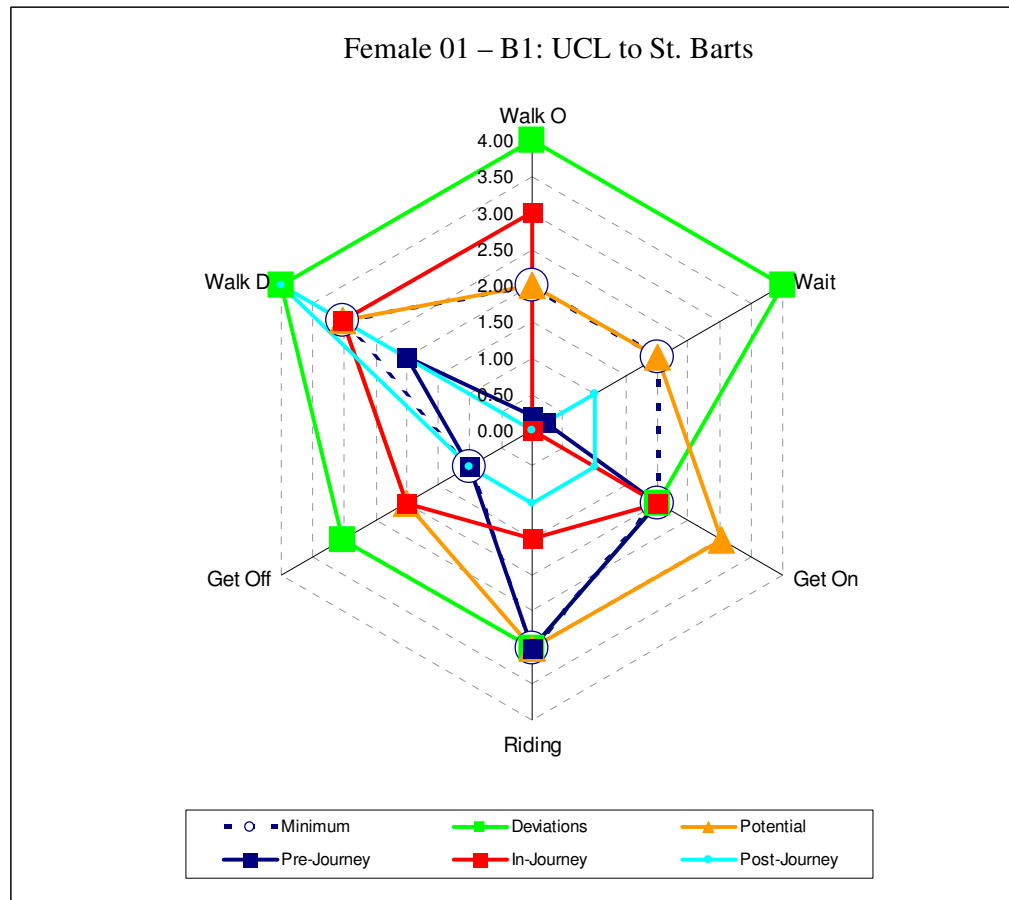


Figure 7.23 – Information Chain Dimensions, B1

In terms of the general information use during B2, Figure 7.24 illustrates an improvement in the process of information to do the journey, resulting in more ‘knowledge consumption’ before the journey (‘**Pre-Journey**’), but not necessarily reflected in the plan strategy. The shapes of the curves for B2 can be considered to be more balanced, covering all the stages and better than those for B1. Also, visually, the difference between ‘**Deviation**’ surface and ‘**Potential**’ or ‘**Pre-Journey**’ surfaces is smaller, indicating an improvement in Capability Awareness, as illustrated in Figures 7.23 and 7.24.

The ‘**Potential**’ of information selected exceeds the boundaries of the ‘**Deviation**’ curve in some stages (‘wait’, ‘get on’ and ‘get off’). The process of information before the

journey ('**Pre-Journey**') is conforming to the deviation (except for the 'walking to bus stop' stage). The '**In-Journey**' curve shows that she consumed more information than she prepared during the 'getting on' stage and the '**Post-Journey**' curve shows that she was worried about the final stages of the journey ('getting off' and 'riding').

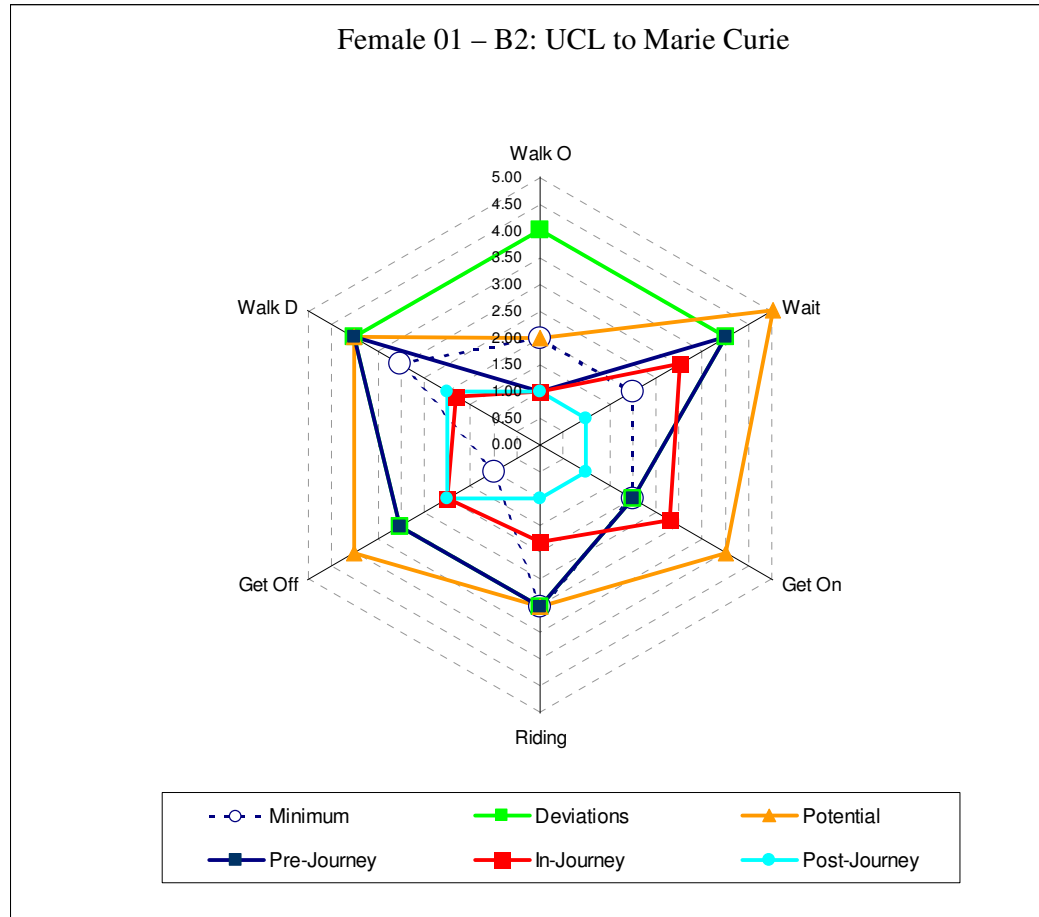


Figure 7.24 – Information Chain Dimensions, B2

In terms of experimental control, in B2, she arrived at the hospital in time, without problems, making connections with specific information ('complete path from bus stop to the hospital') she demanded, after planning, and recognised the hospital entrance picture. The participant required 40 minutes just to do the journey. The actual time taken to execute the journey was 35 minutes. The appointment was fixed for 12:30; she arrived at 12:05.

In relation to the expected results this participant can be considered, a success, having substantial improvements in both quantitative and qualitative parameters. It is worth mentioning that she is also the participant with the greatest impairment. It is possible

that the experiment methodology might be more sensitive to people with moderate to severe physical and sensory impairments and regular to weak cognitive competence where the AI-type information would make a difference in practical terms.

Concerning the usefulness of AI-type of information it can be said that this participant has incorporated the importance of this type of information even though it was after plan composition.

7.4 CONCLUSIONS ABOUT THE LONDON CASE

The methodology created to investigate how (older) people use information was applied to three participants in London. When considered at an aggregated level, using the standard of SCA analysis it seems that the treatment did not have an impact in the participant's behaviour. The absence of formal alteration in the participant's behaviours can be explained by some points.

- i. The phenomenon observed is complex and the analysis based on the plan could not show evidence of behaviour alterations; or
- ii. More journey-exercises are necessary to exploit behaviours changes;
- iii. Behaviour alterations (tendency to value accessible information) were observed during treatment (Tables 7.12, 7.29 and 7.33), when the stages were isolated, but again the high values (>6) evaluated in the stage analysis were not transferred for the overall journey. The risk analysis by stages also showed that the participants are conscious of the importance of information but cannot assimilate them to alter their own planning strategy (use the AI-type information during the planning exercise).
- iv. The process of the information acquisition is unique by participant and specifically related to the journey s(he) is engaging into; so analysis based on CM makes more sense, comparing what was processed before the journey; what was used during the journey and what was retaining after the journey. The deviation curve (the theoretical interaction between the individual and the environment) can be used to support specific training to improve awareness of individual' limitations and environmental issues.
- v. Better formulation of the procedures related to the In-Journey exercise (execution of the journey in the real environment) as well as objective measures of stimulus received in real life (e.g.: skin conductance and heart rate) should enrich the analysis

of the CM and explore the effect of the environment hazards and the information faults throughout the journey.

- vi. Better codification (objective-base) of the different forms of tests applied (drawings, oral, pictures, token manipulation) are necessary to increase validity of each test procedures.

The results obtained cannot be generalised in relation to a wider population due to the complexity and characteristics of the object of study which involves the specific interaction between the individual capability provided and the required environment capability. However, in terms of the individuals concerned the experiment has revealed useful information about how they use information for the planning and execution of a public transport journey. Some evidence points to some directions that should be investigated in further research, for example:

In general:

- i. Participants' knowledge of information potential (what information can reveal) is weak;
- ii. Information Awareness is easier to improve by training than Capability Awareness;
- iii. Capability awareness is more difficult to treat because it deals with the individual's limitations in relation to environment features;
 - a. Difficulties can be divided into two types: the person's inability to understand their own limitations and their inability to understand environmental pitfalls;
- iv. Information Systems with AI-type of information might help to enhance Capability Awareness, particularly for people with moderate to severe impairment;
- v. AI-type of information is valuable according to the participant's perception but it is hard to make participants incorporate it in their planning strategies. It seems it is hard to take information on board when it is not available in the real Information System;
- vi. The simple selection of AI-type of information piece does not guarantee its effective use (mental process and effective application) in individual plan strategies;
- vii. Participant's plan strategies are poor;
- viii. Participants count a lot on supportive information found in the real environment (street name, orientation signs), environment clues (natural and artificial landmarks) and on third person orientation advices.

By Participant:

- i. Male 1: This participant has improved his planning strategy (mostly time-wise) and has adopted Journey Planner as the main method to collect information.
- ii. Male 2: He can be considered to be the most difficult participant to react to experiment procedures. On some occasions, in the treatment phase, he adopted constant high values for judging information importance (e.g. constant value of 10,

Table 7.29). The output-measures can indicate his limitations and identify the weakness in his plan strategy.

- iii. Female: This participant can be considered a success in experimental terms, having substantial improvements in both quantitative and qualitative parameters.

The methodology applied in the experiment can act as a guide to train elderly people in different matters:

- i. to use more modern techniques, such as Journey Planner;
- ii. to improve their metacognition, (and consequently to improve their confidence) helping them to identify what should deserve more attention in the planning phase according to the recommendations of their own deviation curves;
 - ii.i To adjust judgments about their own plan quality, overestimated most of the time, what could induce errors and lack of care about specific stages of the journey;
- iii. to reduce the time wasted to plan a journey;
- iv. to improve the use of the bus system which can be a more friendly mode for older people and;
- v. to increase mobility patterns once they can get more confident to plan and execute the journey independently.

In terms of environment, the directive (viii, general evidence: Participants count a lot on supportive information found in the real environment) might constitute some evidence that a good and consistent orientation system (that could cover the environment-link between public transport stations (bus stops and tube/rail stations) and public transport services (hospitals, libraries, schools, museums) can help disabled people.

In relation to the format of the INFOChain experiment, there are some considerations: Although the number of participants is small, a consistent positive evaluation related to the importance of information is observed during treatment phase. Tables 7.12, 7.29 and 7.33 illustrate the values of importance attributed to AI_type information during the treatment phase, in which the information was analysed by stages of the journey, when the participant was focusing on the aspects of the stage, individually. The values are considered high (>6). Unfortunately, such kind of consideration was not enough to affect the participants' strategy (modification in the use of the information) during the return to baseline condition as was expected by the working hypothesis. Time constraint and the impossibility to take pieces of information on the real journey exercises might have affected the practical considerations about AI_type use during the experiment applications. More investigations about the effect of the time constraint and the access to information (portability) need to be evaluated in future applications of the INFOChain methodology.

8 INFOCHAIN-BR RESULTS: THE BRASILIA CASE

Chapter 7 presented the results of the experiment applied at a big European urban centre – London, the capital of England. This chapter presents the results of the experiment applied at a pre-planned Brazilian big urban centre – Brasília, the capital of Brazil. The presentation starts with considerations about the settings: the features of the journeys (The Environment Capability Required) conducted by participants followed by the participants' profiles presented in Section 8.2 (The Individual Capability Provided). Section 8.3 discusses each individual's choices and the outputs (Outputs of Baseline 1, Outputs of Baseline 2, Main Differences between Baselines and Experiment Output Conclusions) and Section 8.4 closes the chapter with a record of the main findings about the Brasilia case.

8.1 EXPERIMENTS SETTINGS: THE JOURNEY(S) ENVIRONMENT

In the Brasília INFOChain experiments, the journeys are distributed around Brasília (Plano Piloto) and in some satellite cities, as illustrated in Figure 8.1. The origin is always the same, at UnB – Universidade de Brasília on the North wing side of Brasília-Plano Piloto. B1 and B2 are real journeys which participants actually executed. T1 to T3 are called treatment-journeys for which participants evaluated information in virtual-journey formats. Figure 8.1 illustrates their spatial location and Table 8.1 describes the main features of the real journeys B1 and B2. Experiments were conducted in September-October/2006.

Table 8.1 – Main features of real journey B1 and B2

B1 - UnB to Hospital Daher
The journey is classified as difficult because it needs interchange at a big coach station Rodoviária do Plano Piloto (Rodo-PP).
Walking from UnB to L2 to get the bus: Commercial and residential area. The traffic flow on the area is intense. The pedestrian flow is also very intense, day-light periods. Distance from UnB to Bus Stop: 718 m or 9 minutes. Crossings: 4 zebra crossings, dangerous because of driver behaviour, the width of the road (3 lanes) and the speed limit (60Km/h). Footways are not formalised, and the path to bus stop is steep. Visual and Physical Connection: immediate vision and physical connections. Recently there has been effort to construct footways inside the campus.
At bus stop: Bus Stop is at L2 South-bound. Layout is not adapted to guarantee minimum gaps (vertical and horizontal) between the platform and the bus floor. There is a concrete shelter with seats but they are very uncomfortable.
Information at bus stop: no information is found at the bus stop.
With Interchange: Wait for bus (many) to Rodo-PP, no information can be found. At Rodo-PP one needs

to find bus stop to Lago Sul via Gilberto Salomão Shopping Centre. The only information available is at the bus pole (list of service (3-point-destination) at the boarding point (See Table B1.6, Annex B1). Remembering that this is a large Bus Terminal area, where there are many bays and many bus poles and no orientation information. No timetable is available. Information about departure time can be obtained if requested at the operator company balcony. The environment at Rodo-PP is confused; noisy, crowded dirty, without seats to wait.

The riding takes 15 to 20 minutes (off-peak). Traffic flow is low (off-peak.)

Hospital is very near the bus stop after Shopping Centre and pedestrian flow is low.

Information at destination: there are some orientation-signs at destination site but they are customised for drivers.

B2 - UnB to Hospital Sarah

The journey is classified as difficult because of a long walk from the bus stop at the destination area. There is no need to interchange.

Walking from UnB to L2 to get the bus: Walking from UnB to L2 to get the bus: Commercial and residential area. Traffic flow on the area is intense. The pedestrian flow is also very intense, daytime. Distance UnB to Bus Stop: 718 m or 9 minutes. Crossings: 4 zebra crossings, dangerous because of driver behaviour, the width of the road (3 lanes) and speed limit (60Km/h). Footways are not formalised, and the path to bus stop is steep. Visual and Physical Connection: immediate vision and physical connection. The environment is reasonably safe during daytime. Recently there has been effort to construct footways inside the campus.

At bus stop: Bus Stop is at L2 North-bound. Bus stop layout is not adapted to guarantee minimum gaps (vertical and horizontal) between platform and bus floor. Bus stop is near a big language course centre and it is used as a parking space by many of the students, impacting driver's maneuvering and consequently affecting the boarding and the alighting conditions (see Figure B1.4, Annex B1). There is a shelter (Glass and steel-iron Adshell type) and wired seats.

Information at bus stop: no information is found at the bus stop.

Wait: The wait in practice can be very long (up to 40 min), the timetable frequency is variable between 20 to 30 minutes.

Riding: takes around 20 minutes (off-peak). Hospital is not visible from bus stop. Pedestrian needs to walk 800m to arrive at Hospital. Traffic flow is low (off-peak).

At bus stop destination: Pedestrian flow is very low, almost isolated. Footways are uneven. There are some orientation-signs at destination site but they are customised for drivers.

Note: There is no rational need to go to Rodo-PP, but some participants have used this interchange as an option.

As explained in relation to the INFOChain-UK experiment, in Chapter 7 (Section 7.1), the full (virtual) description of the environment where the journeys were set constitutes the Required Environment Capability to complete the journey in the real environment.



Figure 8.1 – Spatial Location of Hospital on Aerial Picture (Google_Earth)

The next section describes the characteristics of the individual participants.

8.2 THE PARTICIPANTS

The recruitment of participants for the Brasilia case was harder than for the London case and the format of the experiment had to be modified. The recruitment was conducted at three different places: at the third-age choral at UNB University, at the UnB neighbourhood church communities and at the elderly association related to a national financial body. No male participant responded to the experiment calls and only two older females were interviewed (both from the church community). The third female participant was a MSc Transport student, 41-years-old.

8.2.1 Health Issues

Table 8.2 summarises the main health characteristics of the three participants. It lists the problems declared by each participant when prompted and the problems (impairment and limitations) identified by the Battery Test (Chapter 5, Section 5.4).

Table 8.2 – Health Issues by participants

Personal Feature	Female 1 (41)	Female 2 (74)	Female 3 (81)
Declared Disease	None	i. Heart problems ii. High pressure iii. Arthritis on both knees	Heart problems
Declared Problem	None	i. Glasses for short and long sights ii. Difficult for walking long distances (> 1km)	Glasses for long distance
Impairments Detected by Battery Tests (Chapter 5)	Physical Impairment None	Physical Impairment i. Step Height: Severe Impairment [0.75]	Physical Impairment i. Head movement (rotation): Mild impairment [0.25]
	Vision Impairment i. Near Vision: Moderate impairment [0.30].	Vision Impairment ii. Long Distance Vision: Moderate impairment [0.40]	Vision Impairment ii. Long Distance Vision: Moderate impairment [0.50]
	Audible Impairment ii. Problem in following oral instructions: Mild impairment [0.25]	Audible Impairment iii. Following instructions: Moderate impairment [0.50]	Audible Impairment iii. Following instructions: Moderate impairment [0.50]
	Cognitive Competence iii. City Knowledge: Weak competence [0.38] iv. Public Transport Knowledge : Weak competence [0.25]	Cognitive Competence iv. Short-Term Memory: Weak competence [0.25] v. Long-Term Memory: Very poor competence [0.17] vi. City Knowledge: Very poor competence [0.13] vii. Imagination: Medium competence [0.29] viii. Spatial Ability: Medium competence [0.41] ix. Public Transport Knowledge : Weak competence [0.25]	Cognitive Competence iv. Short-Term Memory: Weak competence [0.25] v. Long-Term Memory: Very poor competence [0.23] vi. City Knowledge: Very poor competence [0.19] vii. Imagination: Very poor competence [0.13]

The subsequent tables show more specific data about the experiment: the participants' knowledge (general and specific knowledge about the destination area), and their feelings (general feelings about Journey Chain) and the time indicator about performance.

8.2.2 Knowledge and Experience

This explores objective and subjective measures of the participant's knowledge and experience with Public Transport and their specific feelings about the bus system (Table 8.3). Knowledge related to the area where the journeys were executed is shown in Table 8.4.

Table 8.3 – The Declared Background Knowledge

Background Knowledge	Unit	Experiment		
		Female 1 (41)	Female 2 (74)	Female 3 (81)
Time living in Brasília	(years)	24	39	34
Experience with PT ²⁷	(years)	32	39	4
Frequency of Use PT		once p/ month	3 to 5/w	everyday
General Knowledge PT		weak	weak	good
City Spatiality Knowledge		weak	medium	weak
Feeling towards bus system	[0-10]	Negative [3]	Positive [10]	Negative [0]

In general, the participants were used to the environment and to the bus system although they did not reveal very good knowledge about the bus system operation. Female 3 has better knowledge about Public Transport although she has been using it only 4 years, but uses it every day. The feelings about the Bus Systems were very different.

Table 8.4 – Previous Knowledge Declared of Destination Area (Scale [0-10])

Journeys	UCL to	Post Code	Knowledge		
			Female 1 (41)	Female 2 (74)	Female 3 (81)
Real Journey 1	Hospital Daher	Lago Sul	1	0	5
Virtual Journey 1	Núcleo Bandeirante	Outside BSB	1	0	6
Virtual Journey 2	Taguatinga	Outside BSB	1	0	2
Virtual Journey 3	Sobradinho	Outside BSB	3	8	0
Real Journey 2	Hospital Sarah	Lago Norte	8	0	3

Specific knowledge declared about the target area was very variable, as shown in Table 8.4.

²⁷ PT – Public Transport

8.2.3 Feelings

Table 8.5 illustrates each participant's Risk Perception and Table 8.6 illustrates the participant's Risk Behaviour along the stages of the Journey-Chain. The scale and interpretation used to measure the participant's risk perception and behaviour were the same as those used in the London case (see Table 7.7).

Table 8.5 – Risk Perception per stage

Stages	Female 1 (41)		Female 2 (74)		Female 3 (81)	
Planning	4.40	Risky	4.20	Risky	4.40	Risky
Walking O	3.60	Risky	4.20	Risky	4.20	Risky
Waiting	4.20	Risky	3.40	Risky	2.20	Mildly Risky
Getting On	2.40	Moderate Risky	3.67	Risky	2.87	Moderate Risky
Interchange	3.00	Moderate Risky	2.80	Moderate Risky	3.80	Risky
Riding	3.00	Moderate Risky	3.40	Risky	2.20	Mildly Risky
Getting Off	2.40	Moderate Risky	4.20	Risky	4.40	Risky
Walking D	3.60	Risky	4.20	Risky	4.40	Risky

Table 8.6 – Risk Behaviour per stage

Stages	Female 1 (41)		Female 2 (74)		Female 3 (81)	
Planning	4.20	Not sure	3.00	Not sure	2.40	Not Sure
Walking O	2.20	Unlikely	2.00	Unlikely	1.60	Unlikely
Waiting	1.80	Unlikely	1.20	Very unlikely	1.00	Very Unlikely
Getting On	4.00	Likely	3.40	Likely	3.40	Likely
Interchange	3.27	Not sure	2.67	Not sure	2.60	Not Sure
Riding	3.00	Not sure	2.00	Unlikely	1.80	Unlikely
Getting Off	4.00	Likely	3.40	Likely	3.40	Likely
Walking D	2.20	Unlikely	2.00	Unlikely	1.60	Unlikely

All participants evaluated at least four risky stages in the journey chain (double the number of stages, compared with London case) and declared that they were either unlikely or not sure to engage in these stages to complete the journey.

Sections 8.2.1 (Health issues), 8.2.2 (Knowledge) and 8.2.3 (Feelings) are the set of characteristics considered by this study to constitute the main part of the Individual Capability Provided. The set of individual's characteristics considered to be related to the proposed activity: the execution of a journey by bus in a real environment.

Section 8.2.4 presents the general performance indicator (time) to complete the experiment.

8.2.4 Performance Indicators

The general experiment performance is given by the total experiment time (Table 8.7) and the time taken to finish the plan exercise only (Table 8.8).

Table 8.7 – BR INFOChain Experiment Total Time (hours and min)

Experiment Total Time (min)	Female 1 (41)	Female 2 (74)	Female 3 (81)
Compact Battery Test	70	101	101
Real Journey 1	48	54	61
Treatment	169	116	117
Real Journey 2	86	26*	131
Total time (min)	373	297	410
Total time (hours)	6h 13min	4h 57min	6h 50min

* The actual journey was not executed. It varies from 30 to 60 min.

Table 8.8 - Planning Task Time (min)

Journeys	UCL to	Post Code	Planning Task Time (min)		
			Female 1 (41)	Female 2 (74)	Female 3 (81)
Real Journey 1	Hospital Daher	Lago Sul	9	6	8
Virtual Journey 1	Núcleo Bandeirante	Outside BSB	7	6	5
Virtual Journey 2	Taguatinga	Outside BSB	8	6	2
Virtual Journey 3*	Sobradinho	Outside BSB	3	3	0**
Real Journey 2	Hospital Sarah	Lago Norte	9	8	6
AVG/participant			7.2	5.8	5.25***

* Time (3min) was imposed by experiment as a constraint.

** Female 3 refused to use any information given. Her strategy is to go to Rodo-PP and ask for Information.

*** Average was calculated without considering Virtual Journey 3

In general no great differences were observed between participants.

The next section examines the individual choices made to complete the proposed activity: the selection and process of information pieces to plan the journey and the choices/coping strategies made in the real environment when executing the planned journey.

8.3 THE INDIVIDUAL CHOICE

Each participant's choices are explored in this section. The analysis starts by revealing the type of information investigated to solve the problem (plan and do a journey by bus) during the five phases of the experiment (real journeys and treatment phases, Chapter 6). In the sequence, some detailed analyses (restricted to real journey phases, B1 and B2) are presented to demonstrate the relation between INFOChain curves: the Deviation (theoretical interactions between individual and environment); the Pre-Journey information before journey execution (accumulated: selected and process); the In-Journey, what was used in order to complete the activity (do the journey by bus) and the Post-Journey information evidence of what information was stored in long-term memory. Finally some comments are made taking into account the feelings declared by each participant for each real journey.

The first participant's results (Female-01, 41 years-old) are presented in detail, in order to illustrate how the analysis was carried out, the other two participants' results are summarised and only the main differences and conclusions are presented in this chapter. Main conclusions about the Brasília Case are presented at the end of this chapter, in Section 8.5.

8.3.1 Female-01 Case

8.3.1.1 Selection of information to compose plans

Table 8.9 lists the information pieces selected to compose the plan for each journey exercise. The table also summarises the subjective participant's opinions about the quality of her plan (test # 6, Table 6.2) and the degree of difficulty in doing the plan (test # 7 of Table 6.2).

Table 8.9 illustrates that the traditional trio of information: the city map, the timetable and the route diagram were kept as her strategy to gather information to compose her plans. In general, she was not very happy with the quality of her plans, except for the last one when she considered the plan was very good.

Table 8.9 – List of Information Investigated to Plan

Experiment Phase	Time (min)	Degree Of Difficulty to Plan	Information Selected to Plan	Plan Quality (subjective opinion)
Real Journey 1 (B1) (Interchange)	9	3 [easy]	i. Brasília's map (macro area) ii. Timetable iii. Route map DFTrans	3 [weak]
Virtual Journey 1	7	3 [easy]	i. Timetable ii. Map of destination area (city area) iii. Route Service DFTrans	3 [weak]
Virtual Journey 2	8	8 [difficult]	i. Map of destination area (city area) ii. (AI) Route sketch with landmarks iii. Route Service DFTrans	2 [weak]
Virtual Journey 3 (Monetary Concept)	3	6 [medium]	i. Map of destination area (city area) ii. Timetable iii. Route Service DFTrans iv. Ticket Values	7 [moderate]
Real Journey 2 (B2) (No Interchange)	9	1 [very easy]	i. Map of destination area (city area) ii. Timetable iii. Route Service DFTrans	10 [very good]

Figure 8.2 shows the potential amount of each type of information (PotE/PotT/PotAI) provided by the information pieces selected by the participant and the amount actually used to compose the plan (w/o) (E/T/AI). The exposition to the T-type and the AI-type information varied along the whole experiment. A weak improvement was observed in the use of the AI-type information into plan procedures in Baseline 2.

As explained in relation to the INFOChain-UK experiment (Chapter 7, Section 7.3.1), Figure 8.2 is the graphic representation of the selection of information (the plan: (w/o), 'the behaviour observed' for the application of the SCA).

Thus comparing Table 8.9 and Figure 8.2 it can be perceived that the analysis based on the simple choice of information (Table 8.9) does not show the differences demonstrated by the plan. These differences appear when the INFOChain Taxonomy to interpret the plan is applied. Figure 8.2 illustrates the attributes of the journey (aggregated by E/T/AI) that appear in the plan.

All the participants' representations (drawings/textual) are presented in Annex A3.

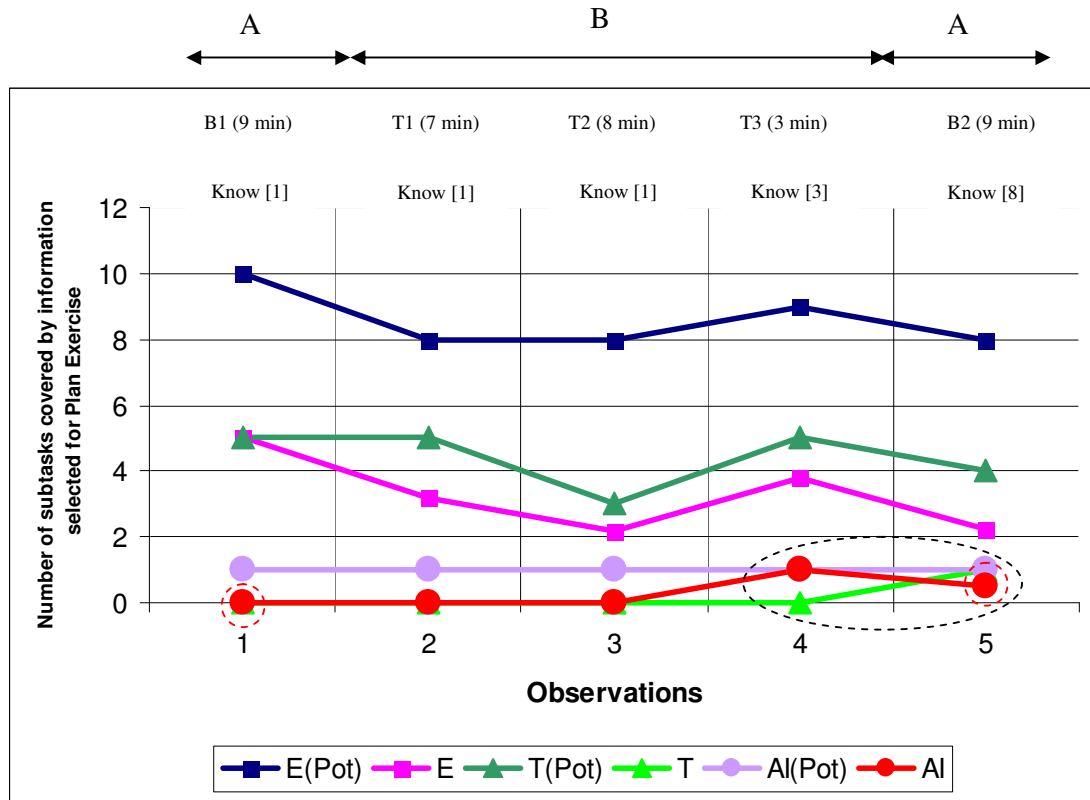


Figure 8.2 – Single Case Results: (Potential & Selected) Information by Female-01

Table 8.10 illustrates the importance attributed to the information, captured considering the whole journey chain.

Table 8.10 – Importance of Information (whole Journey-Chain analysis)

Experiment Phase	Information Importance (whole Journey-Chain analysis)	
B1	Before Journey ii. Brasília Map iii. Type of vehicle iv. Route diagram (DFTrans)	After Journey (Virtual Journey Analysis): v. Route DFTrans vi. (AI) Route diagram on map with reference pictures vii. Timetable
T1	Before Journey: iii. Timetable iv. Map of destination area v. Route of service (DFTrans)	
T2	Before Journey i. Map of destination area ii. (AI) Route diagram on map background with reference pictures along the journey iii. Route of service (DFTrans)	
T3	Information selected: i. Map of destination area (1T) ii. Timetable (1T) iii. Route (DFTrans) (2T) iv. Ticket value (1T) v. (AI) Route diagram with pictures of reference (2T) vi. (AI) Complete drawing map bus stop-hospital (2T)	Information bought: iii. Map of destination area (1T) iv. Timetable (1T) v. Route (DFTrans) (2T) vi. Ticket value (1T) Total tokens given to participant: 5T

	Total tokens selected: 9T	
B2	Before Journey: iv. Map of destination area v. Timetable vi. Route diagram (DFTrans)	After Journey (Virtual Journey Analysis): i. Timetable ii. (AI) Route diagram on map with reference pictures

It is perceived that the AI-type information was considered important on some occasions.

Table 8.11 reveals some details during the treatment phase of experiment where the value of information is extracted by stage. Table 8.11 shows that this participant considered the AI-type of information useful and she was able to identify the hazards involved in each stage of the journey. Fall and assault are recurrent perceived risk events which underlined the bad system design and her concerns about safety issues, respectively. There are many examples related to the lack of information of Brasília Bus Systems, e.g.: get wrong direction, miss destination and get wrong bus; events that could be minimised with appropriate information items. ‘Broken bus’ reveals her concerns about the precarious state of the bus fleet and the maintenance standards.

Table 8.11 – Most Important Information selected by stage, during Treatment Phase,

Journey	T1		T2	
Stage	The most important Information	Risk	The most important Information	Risk
Walking	(AI) Complete path drawing to bus stop [10]	Knocked down Fall Assault	(AI) Sequence of pictures with references [10]	Knocked down Fall Assault
Waiting	(AI) Environment around bus stop [8]	Get wrong bus Assault No bus on service	Frequency of services (Timetable) [7]	Get wrong bus Assault No bus on service
Getting on	Know which door to get on (suggested by participant) [8]	Lost the bus (because of the door) Fall Drop things	(AI) Description of bus stop layout [5]	Lost the bus (because of the door) Fall Drop things
Riding	Have a conductor to ask (suggested by participant) [10]	Missing destination stop Fall Assault	(AI) Route diagram with references [8]	Broken bus Assault Wrong information from people
Getting off	(AI) Free space to get off (Bus stop layout) [7]	Fall Assault Step on mud	(AI) Description of bus stop layout [5]	Fall Shock with a third person
Walking	(AI) Sequence of pictures of the path to final destination [9]	Get wrong direction Fall Assault	(AI) Complete path drawing from bus stop [10]	Get lost Assault Knocked down

The next Subsections 8.4.1.2 and 8.4.1.3 explore the results obtained with the real journey exercises, B1 and B2.

8.3.1.2 Results from Real Journey 1: UnB to Hospital Daher

A brief description of the journey was introduced in Section 8.1. Table 8.12 illustrates the set of information selected to construct the plan for this first journey: Brasília's map + Lago Sul Timetable + Route map 100.2 and 147 (DFTrans). The timetable and the route map are official information types produced by DFTrans. The time table is available by internet but the route map is not available for the public.

Table 8.12 – Information Gathered to Initiate Journey B1

REAL JOURNEY B1 Information Used to Compose PLAN: Brasília's map + Lago Sul Timetable + Route map 100.2 and 147 (DFTrans)							
Stage	#	Type of Information		Potential	Selected	Processed	Selected + Processed
Walk O	1	Path identification Information	E	1		0.5	0.5
	2	Distance (time) to walk	T	1			
Wait	9	Bus Stop Identification	E	1	1	1	1
	13	Waiting time	T	1		1	1
Get On	15	Bus Service Identification	E	1	1	1	1
Interch	20	Path identification	E	1		1	1
	21	Bus Service Identification	E	1	1	1	1
	22	Time wasted at interchange*	T	1			
Ride	24	Landmarks References	E	1	1	1	1
	25	Direction	E	1	1	1	1
	26	Distance (time or km)	T	1		1	1
Get Off	28	Landmarks References	AI	1		1	1
	29	Bus Stop Identification	E	1		1	1
Walk D	32	Path identification	E	1		1	1
	34	Distance to walk	T	1			
	40	Target (Hospital) identification	E	1		1	1
TOTAL				16.00	5.00	12.50	12.50
Total E				10.00	5.00	9.50	9.50
Total T				5.00	0.00	2.00	2.00
Total AI				1.00	0.00	1.00	1.00

Table 8.12 illustrates that from the 16 attributes that could be potentially used, only 5.00 points were formalised in the plan representation (31%, weak process, Table 7.16).

Details of the plan task can be verified in Table 8.13.

Table 8.13 illustrates that the plan (written/oral) only formalised bus services (two alternatives), some sort of direction for the riding stage (landmarks references: the bridge, "Ponte das Garças").

Table 8.13 – Outputs extracted during planning exercise

The Plan Sheet	Details of the plan
<p>PARANOÁ - RODOVIARIA 100.2 SÃO SEBASTIÃO / RODOVIARIA PP (PONTE DAS GARÇAS) 0.147</p>	<p>Transcription: Paranoá-Rodoviária 100.2 São Sebastião/Rodoviária PP (Ponte das Graças) 0.147</p> <p>Translation: 2 alternatives bus services: i. 2 destination points (Paranoá-Rodoviária) + number of the bus (100.2) ii. 2 destination points (São Sebastião/ Rodoviária PP) + 1 landmark reference (Ponte das Garças, a bridge) and the number of the bus (0.147)</p> <p>Oral version: “Go to Rodo PP then get a bus (100.2) to Lago Sul”</p> <p>Extra questions: i. Difficulties anticipated: Might have trouble at the interchange point because of the time. ii. I would like to see the interchange point more organised. iii. Personal strategy if problem occurs: Ask around. iv. Preference mode: “Car or taxi, because of the time issue.” v. Reliability of Bus [0-100%]: 5% confident he would arrive at the destination on time.</p>

The same rationale was used for the score obtained for the information processed before the journey execution, represented in Table 8.12 (‘Selected + Processed’ column). Table 8.14 illustrates the three main outputs obtained during the application of the tests to extract information processing: The Representation of Journey, The Token Manipulation and The Technical Questionnaire. The application of the tests revealed that substantially more information was captured (12.50, representing 78% - a good level of process, according to Table 7.16)

8.14 – Tests outputs - extracted (processed) information before journey

Representation of Journey

14. Agora, que você planejou sua jornada, por favor, use o espaço abaixo para representá-la.

Token Manipulation

Technical Questionnaire

How to arrive at bus stop	on foot
Bus #	many to Rodo. From Rodo I don't know
Departure	don't know
Frequency	don't know
Duration trip inside bus	15 min., according to the map
Where to get off	Ask conductor Ponte das Garças
How to arrive at destination	walk from bus stop
Duration of the journey	45 min
Cost	I don't know

Table 8.15 illustrates the awareness of information by stage. The ‘Walking to Bus Stop’ was weakly represented, only 25%, which can be interpreted as the result of the participant’s familiarity of the area (she is a student at UnB). Figure 8.3 illustrates the difference between information processed and information provision (potential information).

Table 8.15 – Awareness of Information per Stage

B1 Stages	Real Info Investigated	Information Processed	AWARENESS Of INFORMATION
	Potential	Pre-Journey	
Walk O	2.00	0.50	25.00%
Wait	2.00	2.00	100.00%
Get On	1.00	1.00	100.00%
Interchange	3.00	2.00	66.67%
Riding	3.00	3.00	100.00%
Get Off	2.00	2.00	100.00%
Walk D	3.00	2.00	66.67%
TOTAL	16.00	12.50	78.13%

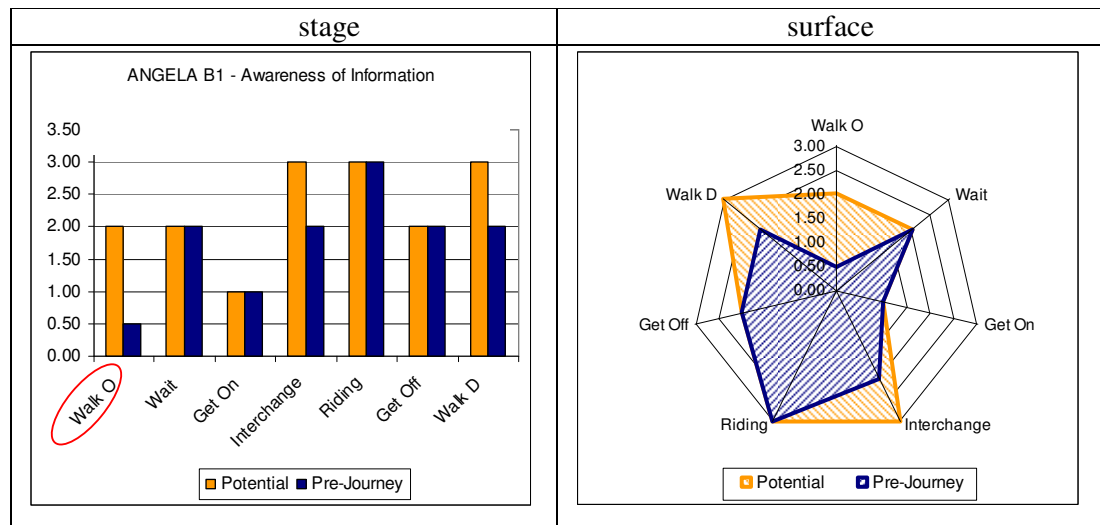


Figure 8.3 - Awareness of Information, before journey, B1

Figure 8.4 illustrates all the curves which translate the individual's use of information (selection, processing and use) for this specific journey.

It can be noticed that the area of 'Potential' information investigated (**SPot**) does not cover all stages recommended by the deviation (**SDev**) curve (being 'Waiting' and 'Interchange' the stages most ignored). For the 'getting on' stage, the Potential region does not cover even the minimum of information recommended to complete it. The participant's information processing (**SPre**) did not take advantage of all the information provided by the information pieces investigated (**SPot**), particularly at the 'walk to bus stop', the 'interchange' and the 'walk to hospital' stages. The curve (**SInJ**) shows that the participant used more information than she had processed during the 'walking to bus stop' and the 'get on' stages, suggesting that this type of information was captured by environmental clues. Finally, the post-journey interview and the representation of the journey (**SPost**) illustrate the important aspects of the journey that this participant considered to be important to report to a third person in order to execute the same journey. In the participant's view the emphasis is on the 'get off' point, the only stage in which the amount of information recommended is higher than the minimum, and equal to what the information investigated could deliver.

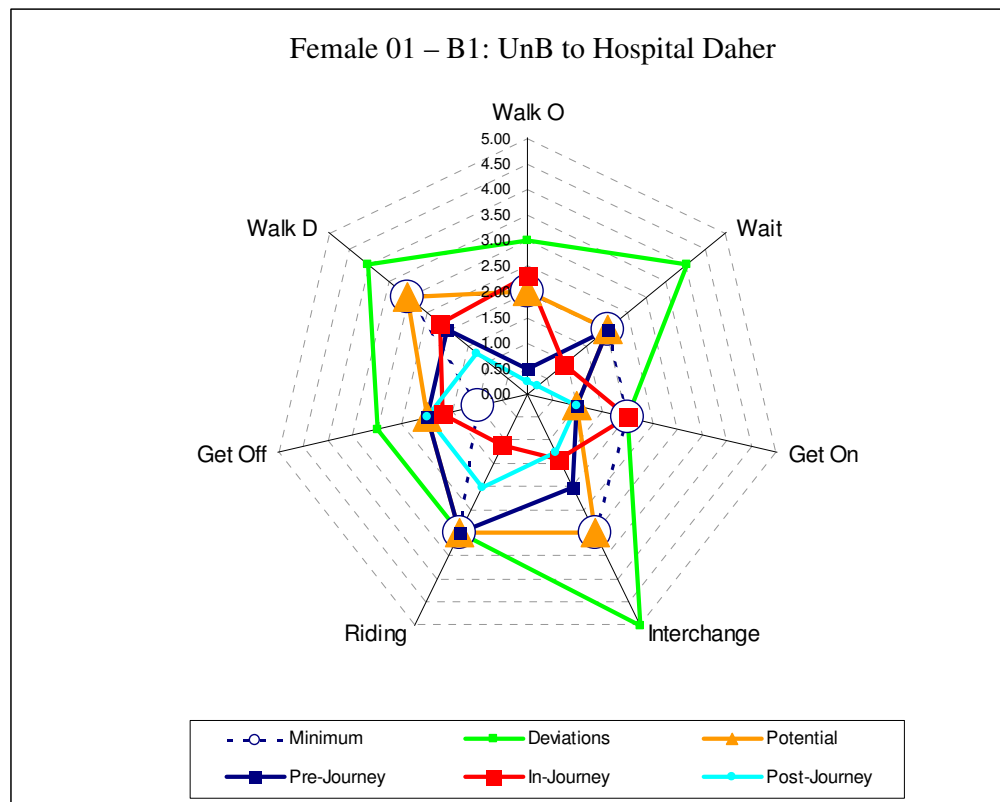


Figure 8.4 – Different Types of Information Manipulation, B1

Table 8.16 and Figure 8.5 illustrate the participant's awareness of capability. In general terms, the awareness of the individual's capability was worse (52%) than the awareness of information (78%, Table 8.15).

Table 8.16 – Awareness of Capability per Stage

B1 Stages	ICp:Ecr	Real Info Investigated	AWARENESS of CAPABILITY
	Deviations	Accumulated	
Walk O	3.00	0.50	16.67%
Wait	4.00	2.00	50.00%
Get On	2.00	1.00	50.00%
Interchange	5.00	2.00	40.00%
Riding	3.00	3.00	100.00%
Get Off	3.00	2.00	66.67%
Walk D	4.00	2.00	50.00%
TOTAL	24.00	12.50	52.08%

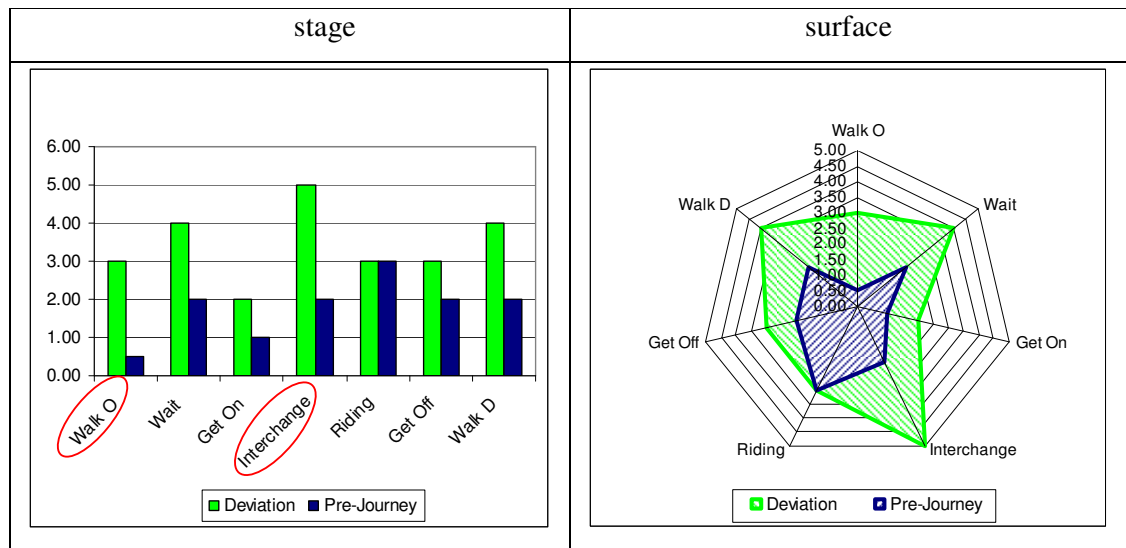


Figure 8.5 – Awareness of Individual Capabilities, B1

‘Riding’ was the only stage fully covered according to the Capability Awareness concept. All the other stages can be considered neglected by participant.

Figure 8.6 illustrates, in more detail, the relation between the information manipulated before, in and after the journey – the curves and the surfaces illustrations.

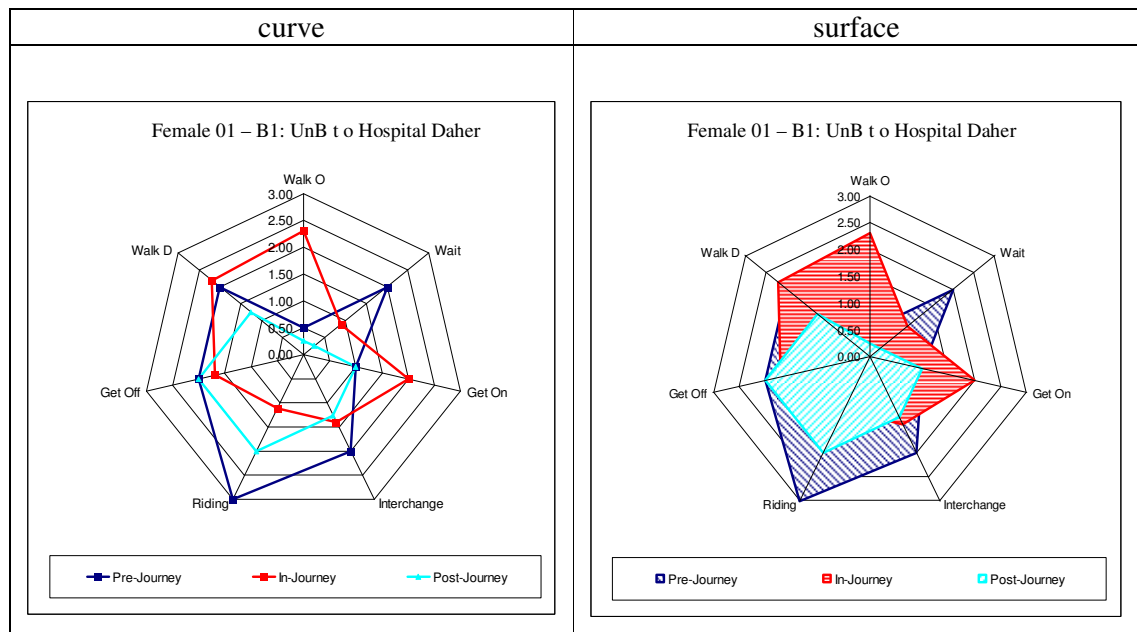


Figure 8.6 – The Pre-Journey, In-journey, Post-Journey Information Curves, B1

The ‘Pre-Journey’ (SPre) and the ‘In-Journey’ (SinJ) information are not synchronised. As described before the ‘walking to bus stop’ and the ‘getting on’ stages consumed

more information (probably from the environmental clues) than was formally processed by the participant, as far as the tests could captured. Finally, the ‘Post- Journey’ information processed (SPos) when compared with what was used the In-Journey (SinJ) shows concerns about the ‘riding’ stage.

Table 8.17 illustrates the faulty stages according to the two different indicators. Faulty stages are stages where the information is below 50%, a weak process of information, according to Table 7.16.

Table 8.17- Faulty stages revealed by Indicators

Indicators	Walk O	Wait	Get On	Interch.	Ride	Get Off	Walk D
Awareness of Information	X						
Awareness of Capability	X			X			

Table 8.18 demonstrates some verbal statements declared during the baseline phase. Figure 8.7 shows the values of anxiety and attention evaluated after the journey execution.

Table 8.18- Coping Strategies, Feelings and Perceptions

Stage	Coping strategy	Feelings/Perceptions
Plan	“Go to Rodo PP then get a bus (100.2) to Lago Sul”	
Walk to bus stop		
Wait		# “Might have trouble at the interchange point because of the time.” # “It was an adventure and at the interchange point I had to wait a lot.”
Get on		
Ride	# “In terms of time it was Ok but the journey itself was full of risks. The tyre was flat, after 3 minutes stopped the driver informed that he was going to continue the journey (slower). The driver said that there was no risk. So I decided to continue the journey.”	# “In terms of time it was Ok but the journey itself was full of risks. The tyre was flat, after 3 minutes stopped the driver informed that he was going to continue the journey (slower). The driver said that there was no risk. So I decided to continue the journey.”
Getting off		
Walk to hospital		“The path to the hospital was easy because the hospital was just on the street I got off but I didn’t know about it, I was a bit concerned to find it.”
# Difficulties and 🙋 Help		

From the quantitative measures of awareness and the qualitative analysis of the data it can be said that the apparent neglect of the ‘Walking to Bus Stop’ stage was, mainly, due to her high knowledge level about the origin area.

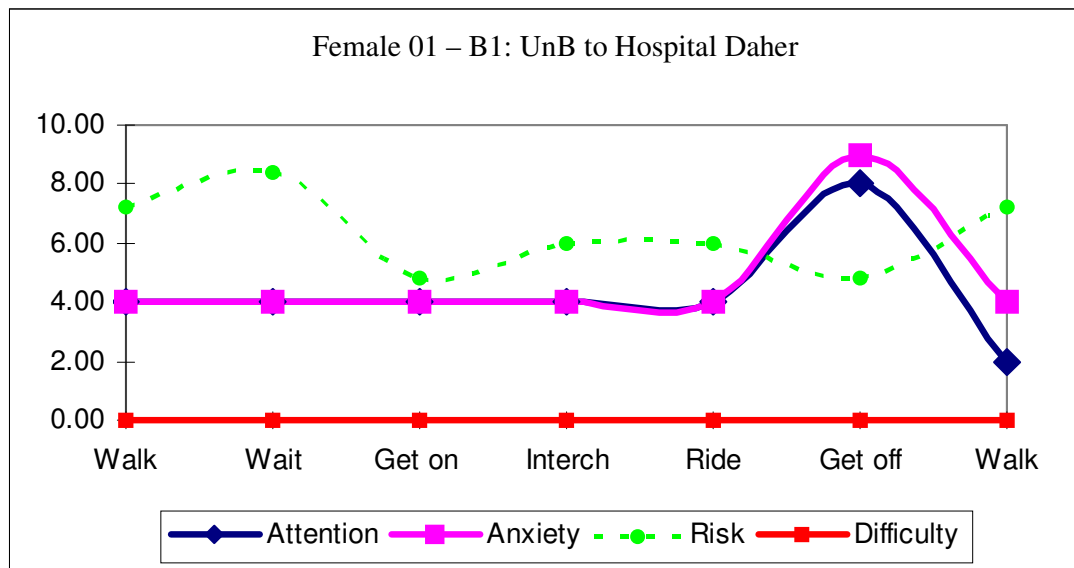


Figure 8.7 – Anxiety and Attention values along the journey, B1

Figure 8.7 illustrates that to be coherent with her feelings, more information should be processed about the ‘Getting Off’ stage. The Post-Journey evaluation (extraction of the attention and anxiety reported levels, question 24 a/b, Chapter 6) revealed that the very end part of the journey (‘Getting Off’ and ‘Walking to Destination’) were the stages about which she was most concerned.

In terms of time, a constraint was imposed (45 minutes) to produce the plan and execute the journey, at the beginning of the plan exercise. When reviewing time issues, the participant believed that 75 minutes would be required just to do the journey. The actual time taken to execute the journey was 49 minutes. The appointment was fixed for 17:15; she arrived at 17:05. She declared (question # 27, Table 6.2) that she arrived at the hospital on time without problems, despite operational complications. For the experimental control, the interviewer’s judgement was that participant arrived at the hospital on time for the appointment, despite some problems.

8.3.1.3 Results from Real Journey 2: UnB to Hospital Sarah

A brief description of the journeys was introduced in Section 8.1 and Table 8.19 illustrated the type of information selected to construct the plan for the first journey: the Map of the destination area + the Lago Norte Timetable + the Route map 136.1

(DFTrans). The map of the destination area is available at newsagents; the timetable and the route map are information provided by DFTrans.

Table 8.19 – Information gathered to Initiate Journey B2

REAL JOURNEY B2 Information Used to Compose PLAN: Map of destination area + Lago Norte Timetable + Route map 136.1 (DFTrans)							
Stage	#	Type of Information		Potential	Selected	Processed	Selected + Processed
Walk O	1	Path identification Information	E	1		1	1
	2	Distance (time) to walk	T	1		1	1
Wait	9	Bus Stop Identification	E	1		1	1
	13	Waiting time	T	1	1	1	1
Get On	15	Bus Service Identification	E	1	1	1	1
	17	Cost	E	*		1*	1
Ride	24	Landmarks References	E	1		1	1
	25	Direction	E	1		1	1
	26	Distance (time or km)	T	1		1	1
Get Off	28	Landmarks References	AI	1	0.5	1	1
	29	Bus Stop Identification	E	1		1	1
Walk D	32	Path identification	E	1	0.25	1	1
	34	Distance to walk**	T	1			
	40	Target (Hospital) identification	E	1	1	1	1
TOT				13.00	3.75	13.00	13.00
E				8.00	2.25	9.00	9.00
T				4.00	1.00	3.00	3.00
AI				1.00	0.50	1.00	1.00

* Cost was not formally given by information system

** Distance to walk: was not present either in selection or in processing phases.

Table 8.19 illustrates that from the 13 types of attributes that potentially could be used, only 3.75 (29%) were formalised in the plan representation. The total of information extracted (selected and processed: 12.00, without considering cost, an information that was not provided by the specific set of information investigated to compose the plan, but known by participant, as revealed by the Technical Questionnaire application) represents 92.31% of what the set of information can offer, which is considered to be a very high level (refer to Table 7.16) of information processing (and higher than B1 (78%))

The information accumulated to compose the journey (the awareness of information) can be interpreted as good enough to complete the journey. However, looking at the Deviation curve (Figure 8.9), which emphasises the difficulties caused by the discrepancies between the individual capability provision and the required capability environment in theory, the participant should have investigated more information and should have planned the journey better. In fact she has encountered many problems

along the journey, both in operational terms (long wait at the bus stop) as well as the need of confirmation to get off. In practical terms, the required information was not available: i.e.: the information system could not tell where the bus was along the route. Because there is no type of information inside the bus (visual/audio) and the bus stops are not plotted in the route map, the driver/conductor was the main source of information.

Table 8.20 illustrates the awareness of information per stage and Figure 8.8 is the visual representation of this

Table 8.20 – Awareness of Information per Stage

B2 Stages	Real Info Investigated	Information Bf Journey	AWARENESS Of INFORMATION
	Potential	Pre-Journey	
Walk O	2.00	2.00	100.00%
Wait	2.00	2.00	100.00%
Get On	1.00	2.00	200.00%
Riding	3.00	3.00	100.00%
Get Off	2.00	2.00	100.00%
Walk D	3.00	2.00	66.67%
TOTAL	13.00	12.00	92.31%

The 200% computed for the ‘get on’ stage revealed that participant knew more information than the information pieces investigated could provide. This particular information was the cost, that for this participant (< 65 years) was a mandatory type of information, and she demonstrated that she knew the value when the Technical Questionnaire was applied.

Figure 8.8 shows that the Potential and the Pre-Journey curves are more synchronised, most of the stages processed what the information could potentially deliver. In the ‘walking to hospital stage’ participant should have processed more.

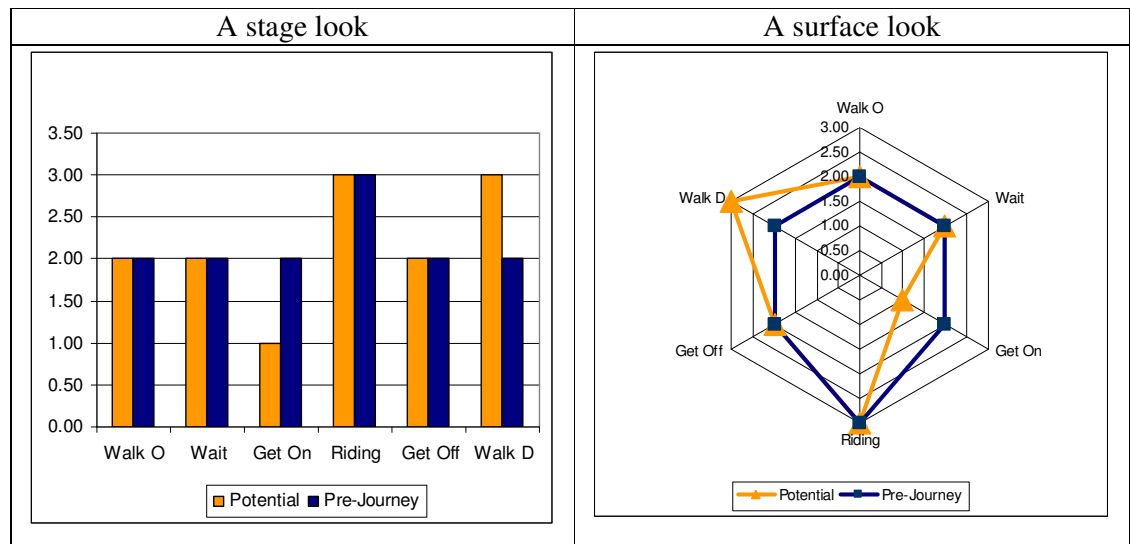


Figure 8.8- Awareness of Information per stage, before journey, B2

Figure 8.9 illustrates all the curves which represent the individual's use of information (selection, processing and use) for this specific journey.

The figure shows that the area of information investigated (**SPot**) does not cover all stages recommended by deviation (**SDev**) (except for the 'riding' stage, where the potential, the deviation and the information processed to do the journey coincide). As a whole, it can be said that because the 'Potential' information investigated is not enough to deal with the set of the theoretical individual capabilities needed to counter-answer the environment capability required (deviation), the participant might find difficulties, particularly, along the final stages of her journey.

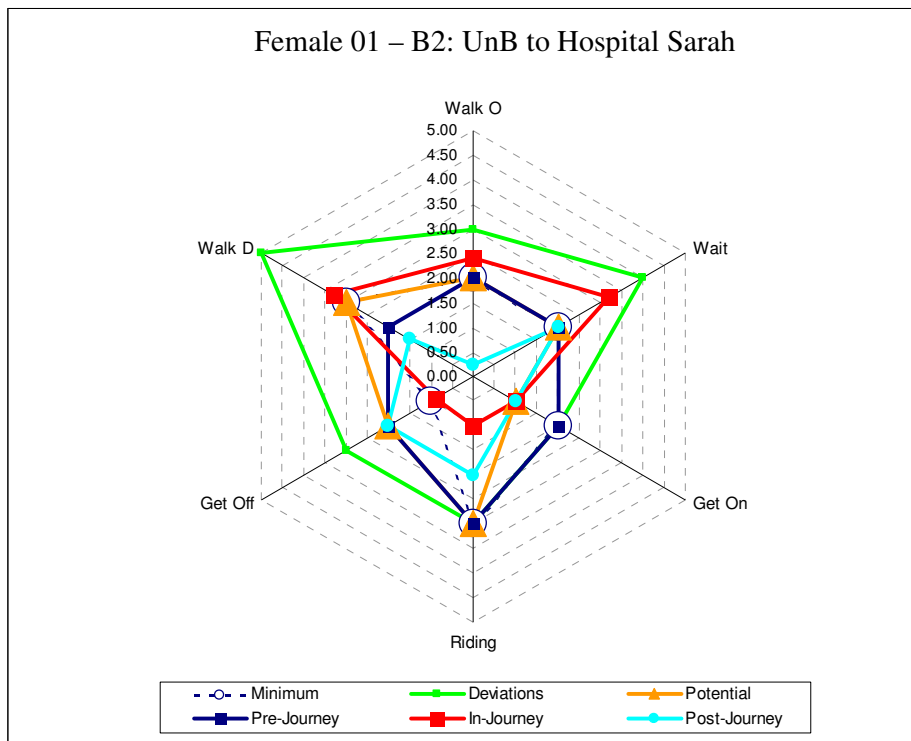


Figure 8.10 illustrates, in more detail, the relation between the information manipulated before the journey – curves and surfaces illustrations. It can be perceived that this participant has investigated information to fully cover her **deviation** along the ‘getting on’ and ‘riding’. All the other stages of the journey should have been considered in more detail.

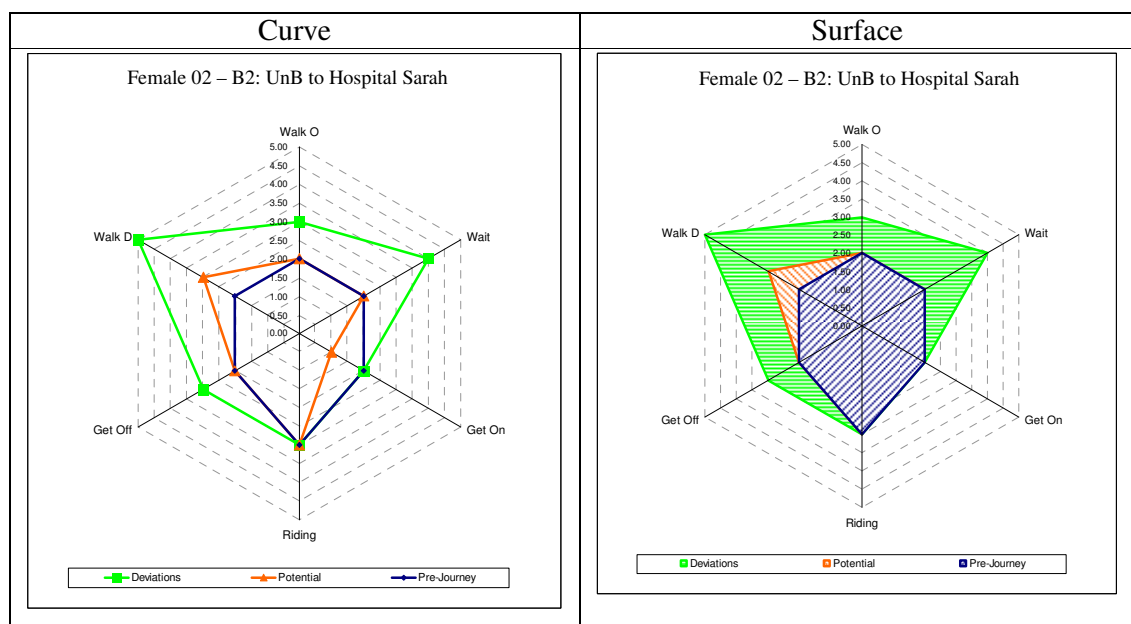


Figure 8.10 – Information manipulated before journey

Table 8.21 and Figure 8.11 show the Awareness of Capability disaggregated by stage of the B2 Journey. In general, the individual's awareness of capability improved (52% to 65%) when compared with Baseline 1.

Table 8.21 – Awareness of Capability per Stage

B2 Stages	ICp:Ecr	Real Info Investigated	AWARENESS of CAPABILITY
	Deviations	Accumulated	
Walk O	3.00	2.00	66.67%
Wait	4.00	2.00	50.00%
Get On	2.00	2.00	100.00%
Riding	3.00	3.00	100.00%
Get Off	3.00	2.00	66.67%
Walk D	5.00	2.00	40.00%
TOTAL	20.00	13.00	65.00%

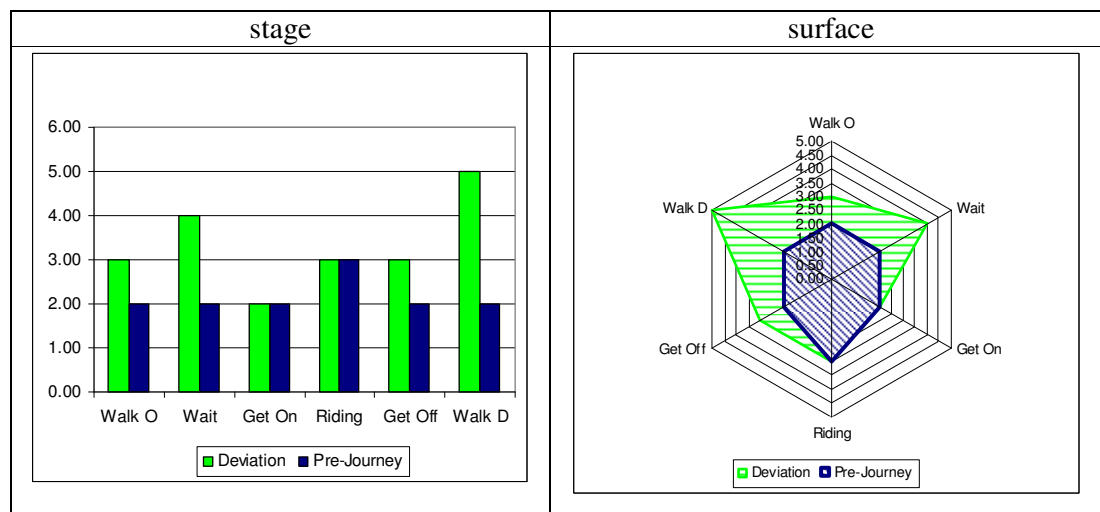


Figure 8.11 – Awareness of Individual Capabilities, B2

Figure 8.12 illustrates, in more detail, the relation between the information manipulated before, in and after the journey – curves and surfaces illustrations. A large part of the **‘In-Journey’** curve is outside the **‘Pre-Journey’** curve (surface) meaning that in the ‘walking to bus stop’, ‘waiting’ and ‘walking to destination’ were stages where the amount of information processed (demonstrated) is not enough to deal with the requirements of the environment. The **‘Post-Journey’** exercise just showed some concerns about the ‘waiting’ and the ‘getting off’ stages. Table 8.23 and Figure 8.13 (coping strategies and feelings curves) show some evidence of these concerns.

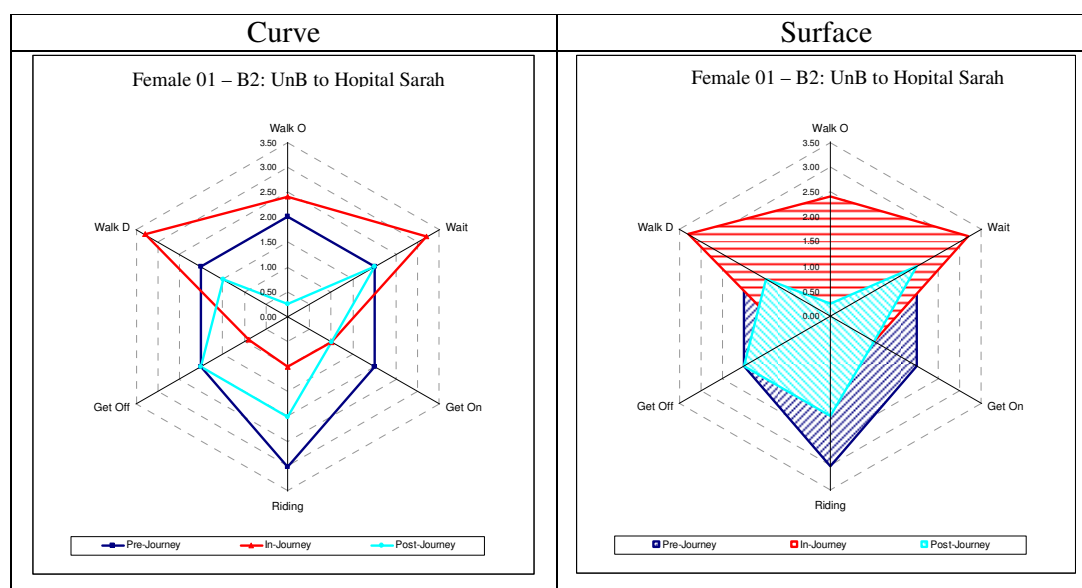


Figure 8.12 – The Pre-Journey, In-journey, Post-Journey Information Curves, B2

Table 8.22 illustrates the stage with problems according to different indicators.

Table 8.22- Faulty stages revealed by Indicators

Indicators	Walk O	Wait	Get On	Ride	Get Off	Walk D
Awareness of Information						
Awareness of Capability						X

Table 8.23 demonstrates some verbal statements declared during the baseline phase.

Table 8.23 - Coping Strategies, Feelings and Perceptions

Stage	Coping strategy	Feelings/Perceptions
Plan	<p>“I knew the area before; I went to visit the hospital once. My original plan was to go to Rodo PP then get a bus to Lago Norte but looking at Lago Norte timetable I realised that there was a bus on L2 going to Lago Norte 136.1 and one starting at Rodo (136). The decision was to do with the frequency which one has more available bus on the schedule 15:00 onwards. The difference is the frequency or to take two buses. I decided to go to L2 and take just one bus. About the destination I thought it was at the beginning of the Lago Norte QI 03 and not QI 13”</p>	<p>“I knew the area before; I went to visit the hospital once. My original plan was to go to Rodo PP then get a bus to Lago Norte but looking at Lago Norte timetable I realised that there was a bus on L2 going to Lago Norte 136.1 and one starting at Rodo (136). The decision was to do with the frequency which one has more available bus on the schedule 15:00 onwards. The difference is the frequency or to take two buses. I decided to go to L2 and take just one bus. About the destination I thought it was at the beginning of the Lago Norte QI 03 and not QI 13”</p>
Walk to bus stop		
Wait		<p># “The wait was difficult, raise my anxiety, and the bus stop was uncomfortable.”</p>

	“I had a long wait at L2, I’ve just waited there is nothing to do.”	“At the waiting stage L2, I have to wait too long” “I had a long wait at L2, I’ve just waited there is nothing to do.”
Get on		
Ride	👉 “Some signs would be helpful but most of them are oriented to drivers. A diagram of the route with all the stops after Bragueto Bridge and a sign of the hospital next to the bus stop. In POA each bus stop is named with the most important landmark nearby, that would be easier for pedestrians”	
Getting off	# “The exact place to get off was another difficult point I needed to ask conductor” # “Where to get off. The alternative is to ask the conductor which is the nearest stop to the hospital. The risk is to get off at the wrong bus stop; be molested by unknown person and the fact that the area is isolated.”	# “The exact place to get off was another difficult point I needed to ask conductor” # “Where to get off. The alternative is to ask the conductor which is the nearest stop to the hospital. The risk is to get off at the wrong bus stop; be molested by unknown person and the fact that the area is isolated.”
Walk to hospital	“... and then confirm the direction of the Hospital with a pedestrian near bus stop at destination.”	
# Difficulties and 🙌 Help		

From the quantitative and qualitative measures it can be said that the participant has improved in terms of acquisition of information. The stress predicted and felt during ‘Waiting’ and ‘Walking to Hospital’ stages, illustrated by deviation curve, could have been avoided if she had made more use of the AI-type piece of information provided by the experiment, such as “Sketched route with landmarks”, where the ‘getting off’ point was clear or the ‘Complete drawing from bus stop to hospital’. Nothing could have been done about the ‘Waiting’ stage, at the time of the experiment was applied, because this was the level of service (and information level) provided by Brasilia’s Public Transport Regulators.

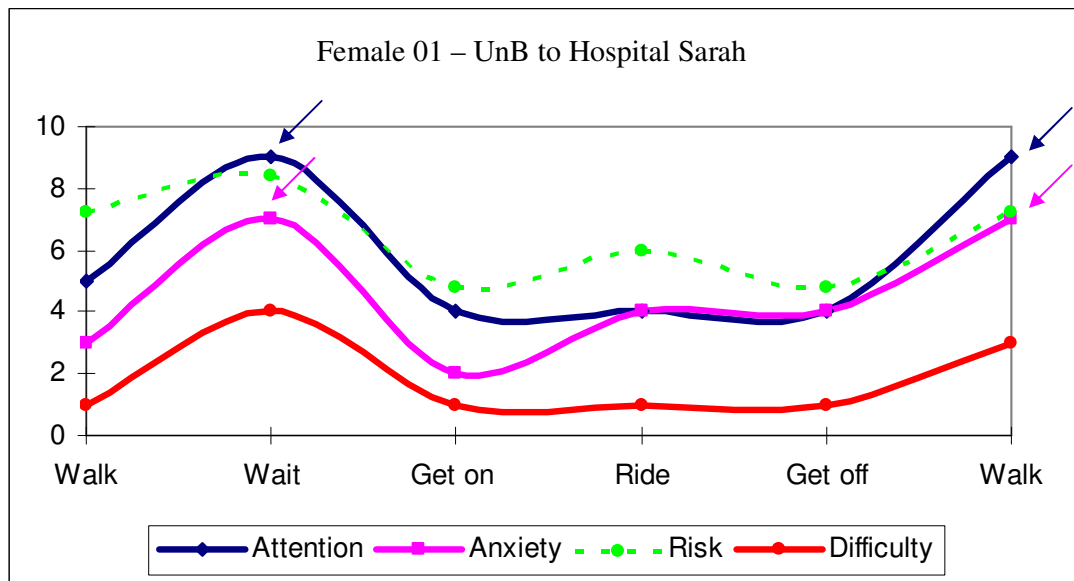


Figure 8.13 - Anxiety and Attention values along the journey, B2

In terms of performance, the participant considered the journey more difficult than the B1, with emphasis at the ‘wait’ stage.

In terms of time, similarly to the first journey, a time constraint was imposed at the beginning of plan exercise (45 minutes) to do the plan and execute the journey. When reviewing time issues, the participant requested 54 minutes to arrive at the destination on time. The appointment was fixed at 15:46, for 16:40. She arrived at the entrance at the hospital at 16:50. The participant has missed the appointment (delay of 10 minutes) due to the long wait at bus stop.

The actual time taken to execute the journey was around 57 minutes. She failed to arrive at the hospital on time; she had to wait a very long period at the bus stop, demonstrating high levels of anxiety.

8.3.1.4. Differences between Female-01 Baseline 1 and Baseline 2 Behaviours

Table 8.24 shows the main results of B1 and B2. Slight differences were observed but mainly due to the impact of the Interchange stage on B1. It can be observed, that, 62.50% (B1) and 61.54% (B2) of information investigated concentrated on answering

essential questions, 31.25% to answer issues related to time and only 6.25% (B1) and 8.00% (B2) is concerned with accessibility issues.

Table 8.24 – Main Differences from Information Investigated and Pre-Journey Information Accumulated, B1 and B2

	Potential				Pre-Journey			
	B1	B1(%)	B2	B2 (%)	B1	B1(%)	B2*	B2 (%)
TOTAL	16.00	-	13.00	-	12.50		13.00	-
Total E	10.00	62.50%	8.00	61.54%	9.50	76.00%	9.00	69.23%
Total T	5.00	31.25%	4.00	30.77%	2.00	16.00%	3.00	23.08%
Total AI	1.00	6.25%	1.00	7.69%	1.00	8.00%	1.00	7.69%

* Knowledge about fare tickets.

Table 8.25 illustrates the evolution of differences between the Information Awareness and the Awareness of Capability.

Table 8.25 – Differences in Awareness, B1 and B2

Journey Stages	AWARENESS of INFORMATION			AWARENESS of CAPABILITY		
	B1	B2	Δ1	B1	B2	Δ2
Walk O	25.00%	100.00%	↑	16.67%	66.67%	↑
Wait	100.00%	100.00%	=	50.00%	50.00%	=
Get On	100.00%	200.00%	=	50.00%	100.00%	↑
Interchange	66.67%	-		40.00%	-	
Riding	100.00%	100.00%	=	100.00%	100.00%	=
Get Off	100.00%	100.00%	=	66.67%	66.67%	=
Walk D	66.67%	66.67%	=	50.00%	40.00%	≈
TOTAL	78.13%	100.00%	↑	52.08%	65.00%	↑

In general terms, some improvements can be observed during a few stages of the Journey Chain for the both types of awareness, mainly during the first part of the journey (the ‘walking’ and the ‘getting on’ stages).

8.3.1.5. Conclusions about Female_01’s Case

In terms of the selection of information (oral and written information used to compose the plan), no improvement is observed. The information investigated was kept to the traditional types: localise destination, identify service and the timetable. No evidence of any concerns with the Accessibility Issues type of information was captured except when the participant was prompted: In this case this participant chose the ‘schematic path from bus stop to hospital’ as an information piece that could help her.

In both cases the area covered while selecting, processing and using information was smaller than the level recommended by the participant's deviation curve, as illustrated in figures 8.4 and 8.9. This can be interpreted to mean that this participant's strategies can be enhanced towards a better understanding of her own limitations and a better plan formulation in order to reduce anxieties and smooth the journey's obstacles, especially where the environment conditions were so adverse.

In terms of performance (execution of journey), B2 journey was found to be more difficult than B1 even with the operational problem in B1.

In relation to the type of information selected to compose a plan, it can be concluded that the poor level of information and the low level of operational service provided by Brasilia's Bus System can impact significantly on the participant's feelings throughout the journey (Figure 8.13, illustrates the relation between the reported levels of anxiety and the lack of support at the 'waiting' stage'). The lack of accuracy of the information provision is one of the major concerns in Brasilia Public Transport Systems and needs repair.

Sections 8.3.2 and 8.3.3 present the results obtained with the replication of the methodology into two other cases: A Female-02 (74 years old) and a Female-03 (81 years old). The subsequent analysis is presented in a short version emphasizing the differences between B1 and B2 and the main improvements during the experiment. A more interpretative approach is used to analyse the participant's coping strategies in the real environment condition. The analysis concentrates in:

- i. Type of information (E/T/AI) used to plan (written + oral versions) during the 5 journeys: the information pieces investigated and the type (E/T/AI) they cover.
- ii. Differences in the pattern of choice of information before and after the treatment;
- iii. Differences in capability awareness before and after the treatment;
- iv. Relation between attention, anxiety and difficulties during the journey and
- v. Success or Failure in achieving the task proposed by the experiment.

8.3.2 Female-02 Case

8.3.2.1 Selection of information to compose plans

Table 8.26 lists the information pieces used to compose the plan for the five journey-exercises.

Table 8.26 – List of Information Investigated to Plan

Experiment Phase	Time	Degree Of Difficulty to Plan	Information Selected to Plan	Plan Quality (subjective opinion)
Real Journey 1 (B1) (Interchange)	6	0 [very easy]	i. Telephone Service	8 [good]
Virtual Journey 1	6	5 [moderate]	i. Telephone Service 156.6: Participant was informed about 160.2 bus but was alerted that the next service was at 16:00 “I cannot use this service. What should I do?” Interviewer showed the participant the information available. The participant has looked at Timetable to NB with difficulties. She used lens to help reading. She found another bus departure time at 09:40.	6 [moderate]
Virtual Journey 2	6	2 [easy]	i. Timetable ii. Route DFTrans	5 [moderate]
Virtual Journey 3	3	2 [easy]	i. Telephone Service ii. (AI) Complete Drawing map bus stop to hospital	5 [moderate]
Real Journey 2 (B2) (Interchange)	8	5 [moderate]	i. Telephone service	5 [moderate]

After the presentation of information that could be used in each phase of the experiment, some minor changes in the plan pattern are perceived, but, most of the time, the direct information via telephone service was her strategy (choice). In general, she thought her plans had a moderate quality and she considered the planning task to be easy to moderate.

Figure 8.14 examines the task to do the plan according to experimental procedures. It shows the potential amount of each type of information (E-Pot/T-Pot/AI-Pot) provided by information pieces investigated by the participant during the experiment phases. The actual selection of information (E/T/AI) was variable. Slight improvements were observed when B1 and B2 were compared: more essential (E) and accessibility issues

(AI) types of information were selected, but in both phases (B1 and B2) the selection was lower than the information system could provide. The plans were restricted to the bus service identification (the number) and direction (the destination name). The participant's representation of all journeys can be found in Annex A.3.

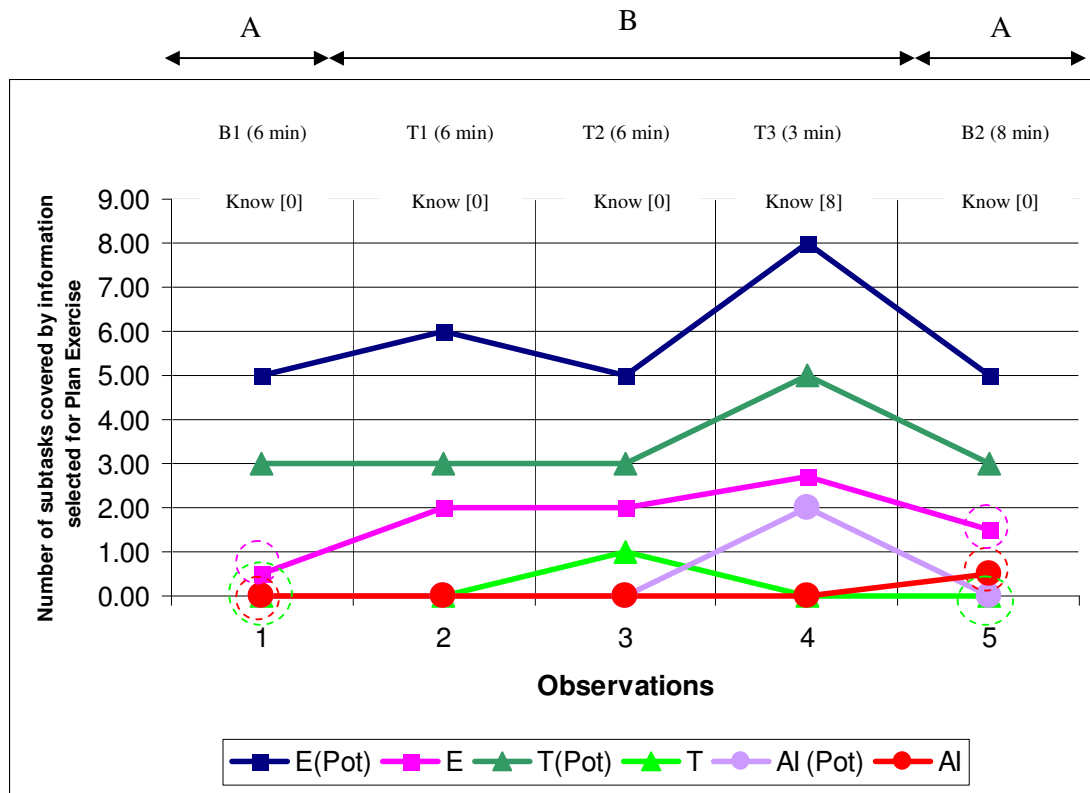


Figure 8.14 – Single Case Results: (Potential & Selected) Information by Female_02

It is worth mentioning that Figure 8.14 illustrates that her best performance, in terms of investigation of information (EPot, TPot and AIPot), was in the treatment phase (T3), while using the Game format, as explained in Chapter 6 (Section 6.2.2.3). In this phase of the experiment the set of information available was presented by stage using a big board in order to reduce the level of manipulation and consequently the participant's working memory load (because everything she needed to compare was in front of her). The core task was to choose the information that might help her. This format of presentation seemed to help this participant.

Table 8.27 reveals some details from the treatment phase of the experiment.

Table 8.27 – Most Important Information selected during Treatment Phase

Journey	T1		T2	
Stage	Most important Information	Risk	Most important Information	Risk
Walking	(AI) Complete path drawing to bus stop [9]	At night is very dangerous: Assault	(AI) Complete path drawing to bus stop [9]	At night is very dangerous: Assault
Waiting	Timetable [10]	Assault	Timetable [10]	Assault
Getting on	-	Fall	-	Fall
Riding	(AI) Reference near the hospital (to get off) [10]	Assault	(AI) Reference near the hospital (to get off, e.g. Top Mall) [8]	Get the first bus at Rodo because buses to Taguatinga are constantly packed.
Getting off	-	Knocked down by a bicycle	-	Fall
Walking	(AI) Reference near the Hospital to know where to go [8]	-	(AI) Complete path drawing to bus stop [8]	High pedestrian flow High and dangerous traffic flow
T3 (Game)	Information selected: Telephone Service (1T) (AI) Route diagram with pictures on map background (2T) (AI) Sequence of picture of reference along the riding stage (1T) (AI) Sequence of pictures of crossings at destination area (1T) (AI) Complete Drawing map bus stop to hospital (2T) Total Tokens: 7T		Information bought: Telephone Service (1T) (AI) Complete Drawing map bus stop to hospital (2T) Total amount of token given to participant: 3T	

Table 8.27 shows that the participant considered the use of some AI-type of information in different stages of the journey and judged them to be useful. In terms of risk she could identify a few: mainly assault and the risk of fall, reflecting her frail condition (arthritis). Even so, the usefulness of AI-type information was only apparent when analysed by stage or in T3 condition but, as illustrated in Table 8.26, it was not transferred to the selection/process of information in the return to baseline condition (B2).

8.3.2.2 Differences between Female-02 Baseline 1 and Baseline 2 Behaviours

Table 8.28 shows main results of B1 and B2. There is no difference in terms of the content of information investigated between B1 and B2. The pattern of the choice of information pieces is absolutely the same; however, differences can be observed in terms of information processed before the journey (Pre-Journey): on B1, 72% of information accumulated was concentrated on being able to answer Essential questions,

in B2 there is more information related to Accessibility Issues. This can be interpreted as evidence that the schema of Journey Chain stages were partially incorporated by this participant although she didn't 'learn' that the AI_type created for the experiment might have helped her to better understand the stages during the journey and in the actual execution of the journey.

Table 8.28 – Main Differences from Information Investigated and Pre-Journey information Accumulated

	Potential				Pre-Journey			
	B1	B1(%)	B2	B2 (%)	B1	B1(%)	B2	B2 (%)
TOTAL	8.00	-	8.00	-	10.75	-	8.75	-
Total E	5.00	63%	5.00	63%	7.75	72%	5.75	66%
Total T	3.00	38%	3.00	38%	2.00	19%	1.00	11%
Total AI	0.00	0%	0.00	0%	1.00	9%	2.00	23%

Table 8.29 illustrates the evolution of differences between Information Awareness and Capability Awareness. Considering the Awareness of Information (Pre-Journey Processed Information by Potential Information, See Chapter 6, Section 6.3), the 'riding' stage shows a 125% of awareness, meaning that the information processed was captured from her memory, she knew more than the information investigated could provide, at this specific stage. The technical questionnaire was the test applied to capture the specific knowledge of the public service operation where the knowledge was demonstrated.

Table 8.29 – Differences in Awareness, B1 and B2

Journey Stages	AWARENESS of INFORMATION			AWARENESS of CAPABILITY		
	B1	B2	$\Delta 1$	B1	B2	$\Delta 2$
Walk O				12.50%	6.25%	↓
Wait	100.00%	50.00%	↓	50.00%	25.00%	↓
Get On	100.00%	50.00%	↓	66.67%	33.33%	↓
Interchange	50.00%	0.00%	↓	16.67%	0.00%	↓
Riding	125.00%	125.00%	=	83.33%	83.33%	=
Get Off				25.00%	50.00%	↑
Walk D				29.17%	28.57%	≈
TOTAL	93.75%	56.25%	↓	35.83%	28.23%	↓

Comparing the general performance between B1 and B2, a decrease can be observed in relation to both indicators: awareness of information and awareness of capability.

In terms of attention, anxiety, risk and difficulties, Figures 8.15 illustrates the participant's behaviours in B1.

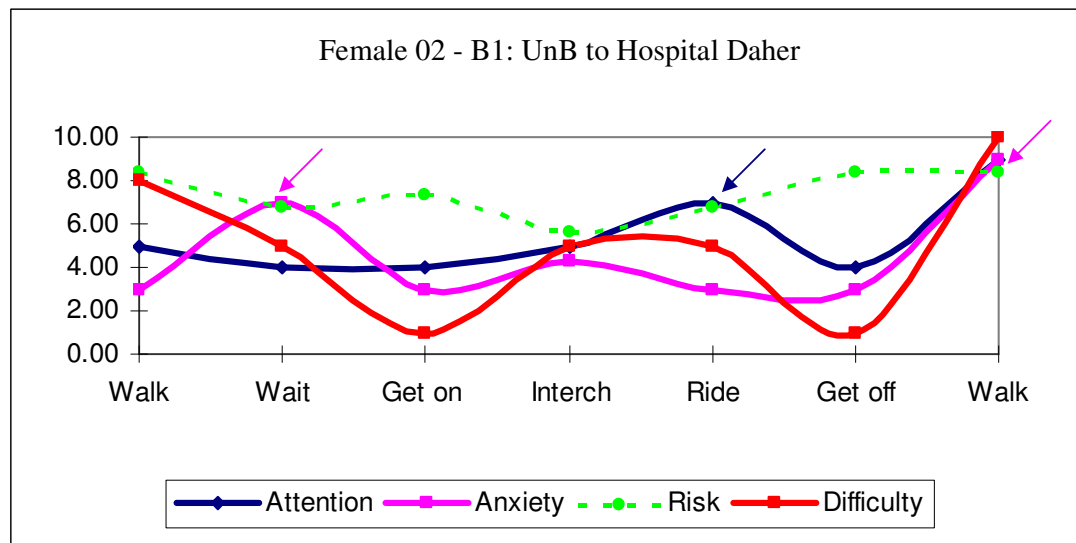


Figure 8.15 – Self Reported Attention and Anxiety Levels, plus perceived risk and difficulties in B1.

The walking stages were considered the most difficult stages, reflecting her physical condition (arthritis). The reason for the high levels in the ‘walk to bus stop’ stage was due to the inaccessible conditions of the area. At the ‘walk to hospital’ stage the participant got lost, as illustrated by Table 8.30, coping strategies at the ‘getting off’ and the ‘walking to hospital’ stages.

Table 8.30 – Coping Strategies, Feelings and Perceptions (B1)

Stage	Coping strategy	Feelings/Perceptions
Plan	<p>“Walk to L2 then get on a bus to Rodo PP (116) look for the 195 bus stop at Rodo and then ask where to get off for the hospital.”</p> <p>“I do not have money for taxi.”</p>	
Walk to bus stop		“I walked to L2, 15 minutes, it was very tiring”
Wait	<p>“... then I found 147.6 bus stop after I have asked to many people for a bus that would go to Hospital Daher. I waited for 30 minutes inside the bus (very tiring, again).”</p>	<p>“... then I found 147.6 bus stop after I have asked to many people for a bus that would go to Hospital Daher. I waited for 30 minutes inside the bus (very tiring, again).”</p> <p>“I had a long wait at Rodo PP, what can you do?”</p>
Get on		

Ride	“The bridge is here, I know I am near the hospital and I need to pay attention. And here is the hospital but I don’t know where exactly”	“The bridge is here, I know I am near the hospital and I need to pay attention. And here is the hospital but I don’t know where exactly”
Getting off	“... Got off after Gilberto Salomão and walked for 25 minutes, the driver gave me wrong direction”	“... Got off after Gilberto Salomão and walked for 25 minutes, the driver gave me wrong direction”
Walk to hospital	“... and 15 minutes walking to the Hospital.” “... I should have done what the conductor said got off at the corner and walked on the main street for 4 minutes”. “This area is very isolated, there is no one to ask and I am afraid of dogs. They have very dangerous dogs here. I would never live here.”	“This area is very isolated, there is no one to ask and I am afraid of dogs. They have very dangerous dogs here. I would never live here.”

The anxiety represented at the ‘waiting stage’ was due to the long time waiting inside the bus (30 minutes) at Rodo-PP. As mentioned before, a combination of the participant’s poor plan strategy (provided capability) and the low bus service level (required capability) resulted in high levels of anxiety that might have been alleviated with the use of the AI-type of information to support participant throughout the stages (previously) perceived as risky (as illustrated by the green-dotted line in Figure 8.15).

In terms of time, a constraint was imposed (45 minutes) to produce the plan and execute the journey at the beginning of the plan exercise. When reviewing time issues, the participant required 70 minutes just to do the first journey exercise B1. At 9:20, the appointment was fixed for 10:30. The journey started at 09:25. The actual time taken to execute the journey was 93 minutes. She arrived too late for the appointment, at 10:58 (28 minutes late). In the participant’s opinion she has arrived on time, despite some problems.

The difficulty found in the ‘walk to hospital’ stage was transferred to the B2 exercise and made as her argument to not execute the second real journey exercise, claiming that the last time (B1: UnB-Hospital Daher, South Lake) was very painful, she felt as if, her blood pressure was very high and because she didn’t know the area, she stated that she could only do the journey by car/taxi.

After the refusal, the interviewer reminded the participant of the AI-type of information at the destination area that could help her. She looked at the information and realised

that she would have to walk around 1.0Km and this reinforced her rejection to do the journey to Sarah Hospital. (See ‘walk to hospital’ stage, in Table 8.31). Table 8.31 demonstrates some verbal statements declared during the planning task and the analysis of virtual-journey B2. The stages of the journey marked (grey) express that the coping strategy is related to the analyses of the virtual journey.

Table 8.31 – Coping Strategies, Feelings and Perceptions (B2)

Stage	Coping strategy	Feelings/Perceptions
Plan	<p>“Walk to bus stop at L2 (North direction), get on 136.6, ask driver if the bus really goes near Hospital Sarah then ask the conductor where to get off to go to Hospital Sarah.”</p> <p>“Car, ask a relative to take me there.”</p>	<p>“Walk to bus stop at L2 (North direction), get on 136.6, ask driver if the bus really goes near Hospital Sarah then ask the conductor where to get off to go to Hospital Sarah.”</p>
Walk to bus stop		<p>“Walk to L2 is tiring but I know the area.”</p>
Wait		
Get on		
Ride	<p>“Walk to bus stop at L2 (North direction), get on 136.6, ask driver if the bus really goes near Hospital Sarah then ask the conductor where to get off to go to Hospital Sarah.”</p>	
Getting off	<p>“... ask the conductor where to get off to go to Hospital Sarah.”</p>	
Walk to hospital	<p>👉 “That picture of yours with the path between the bus stop and the hospital.”</p> <p>“I will seat, rest and then walk again, like I did the last journey. Oh that was a long walk”</p> <p>Note: Real Journey was not executed.</p>	<p># “Difficult will be to walk from bus stop to the Hospital because I don’t know the area.”</p> <p>“I will seat, rest and then walk again, like I did the last journey. Oh that was a long walk”</p> <p>Note: Real Journey was not executed.</p>

8.3.2.3 Conclusions about Female-02 Case

In terms of the use of information use, Figures 8.16 and 8.17 illustrate that, in general, the participant’s curves are below deviation recommendations in both cases, meaning that the participant should have collected and processed more information (than she actually did) in order to deal with the environment pitfalls (physical and at information level). The exception is the ‘**In-Journey**’ curve which shows high levels of information ‘consumption’ at the walking to bus stop stage. This can be explained by the difficulties observed by the interviewer and reported by the participant while she was walking to

the bus stop environment (refer to Table 8.1). In this specific case the prediction made by deviation curve (the theoretical output of the interaction between the individual capability provided and the required environment capability) failed. In reality the difficulties perceived by both the participant and the interviewer were greater. This can also indicate that the deviation curve needs to be recalibrated. The comparison ICp:ECr (the effort limits) needs to be rechecked.

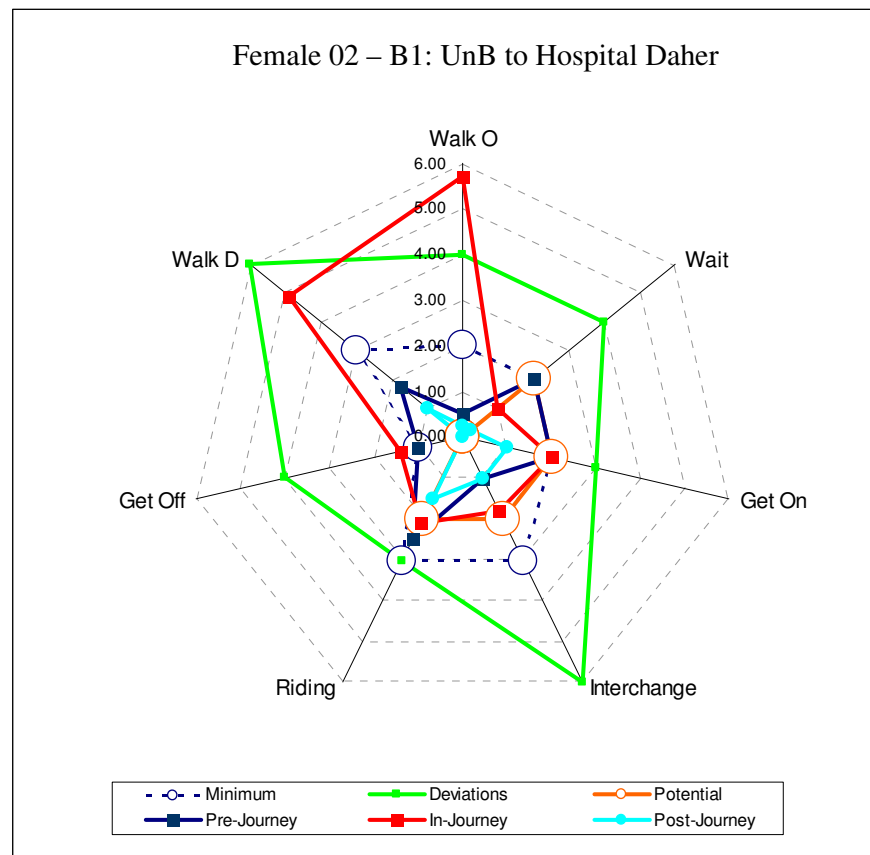


Figure 8.16 - Information Chain Dimensions, B1

In relation to the investigation of information to compose plans (potential), it seems that the current level of information provision is so low and inaccessible that the participant basically relies on what she has already in mind (Processed).

Analysis of the plan document shows that there is no visible ‘rationality’ in the use of the information pieces to construct the plan. The basic rule is to ‘go to Rodo-PP and there you will find the bus service you need to go to where you want’ which represents her individual rationality (bounded rationality) for executing a journey in Brasília. The practicality to apply such a strategy means having long wait periods at Rodo-PP (which

was perceived as 'tiring', Table 8.30) and the result might be lose the appointment, as happened in B1 and lose her independence, as highlighted in B2. A more general but worse impact of such coping strategies could be a negative affection (rejection) towards the bus mode, demonstrated by the B2 rejection, although in terms of the general feeling towards the bus systems, tested by Battery Test, her judgement was high ([10], see Table 8.3).

A comparison in terms of performance (execution of journey) was not possible because she refused to do the journey to Hospital Sarah. But the refusal can be considered an output and clearly illustrates her dependence on a third person to execute a simple task as simple as going to the hospital. On the other hand, the hospital (Hospital Sarah) does have a step-free vehicle to collect patients that need to do schedule-physiotherapy-sessions.

In the case of the B2 Journey, the potential information selected just covers some stages along the journey, as can be seen by Figure 8.17, although the participant has demonstrated more knowledge about 'getting off' and 'walking to the hospital'

Concerning the acceptance of the AI-type information it seems that she thinks they can be useful but she is not ready to use them. The participant allows a third-person-dependence and might arrange the appointment for when a relative could take her.

Her choices are neither the best options nor the easiest ones. Her plans are extremely rudimentary and the effort to obtain the information before starting the journey is minimal, meaning it is oriented towards the minimum. (Typical behaviour already underlined by other researchers (Lyons *et al.*, 2002)).

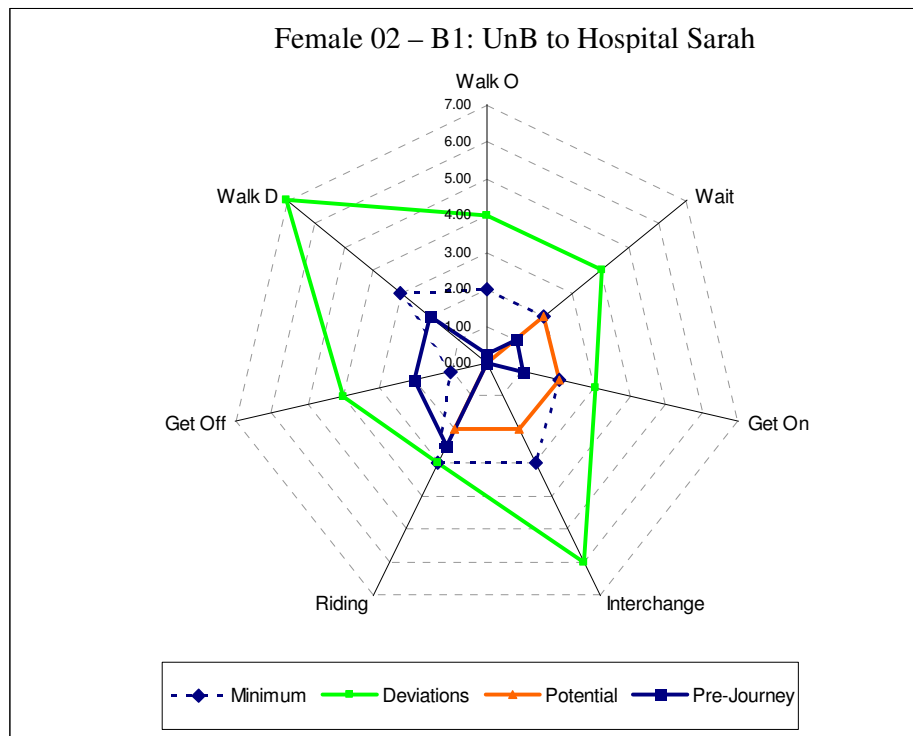


Figure 8.17 - Information Chain Dimensions, B2

Training sessions to show her the potential of each type of information piece and specific sessions oriented to self-awareness limitations might improve her planning strategy and might reduce her levels of anxiety and dependence. Better orientation systems implemented throughout the whole Journey Chain should improve confidence and reduce the participant's dependence.

8.3.2 Female-03 Case

8.3.3.1. Selection for information to compose plans

Table 8.32 lists the information pieces used to compose plans for the five journey exercises.

Table 8.32 – List of Information Investigated to Plan

Experiment Phase	Time (min)	Information Selected to Plan	Degree Of Difficult to Plan	Plan Quality (subjective opinion)
Real Journey 1 (B1) (Interchange)	8	Called 156.6 ask for direction but got no answer. Refused to use any map. Decided to go to Rodo-PP and ask.	9 [difficult]	[not applicable]
Virtual Journey 1 (Interchange)	5	Timetable	5 [moderate]	8 [good]
Virtual Journey 2 (Interchange)	2	Timetable	6 [moderate]	5 [moderate]
Virtual Journey 3 (Interchange)	-	-	6 [medium]	6 [moderate]
Real Journey 2 (B2) (Interchange)	6	i.Brásilia's map ii.Timetable	5 [moderate]	5 [moderate]

Table 8.32 illustrates some minor changes in the plan pattern but, at first, the direct information via the telephone service was the choice for this participant. When the system was not working she adopted the timetable as the alternative main source to acquire information. In general, she thought her plan was moderate and the plan exercise was considered an easy to moderate task.

In the first journey B1 (real journey exercise) the participant tried to use the Telephone Information Service from GDF (her natural strategy to plan a journey). Unfortunately the service was not working. The interviewer advised the participant that she could use the other pieces of information provided by GDF (e.g.: timetable, route map) but she refused to use them and decided to go to Rodo-PP and find her way from there.

In the third journey of the treatment phase (T3), the participant did not want to choose any kind of information. The plan was restricted to some points plotted on the blank sheet which she named as: Rodo-PP, Sobradinho and Rodo-Sobradinho with some

interrogation marks (meaning that she would ask when she arrived there). The participant's representation of all journeys can be found in annex A.3.

Figure 8.18 shows the potential amount of each type of information (E/T/AI) provided by information pieces selected by the participant during the experiment. The pattern of the information selection (E-type, T-type and AI-type) was variable. Slight improvements were observed when comparing B1 and B2.

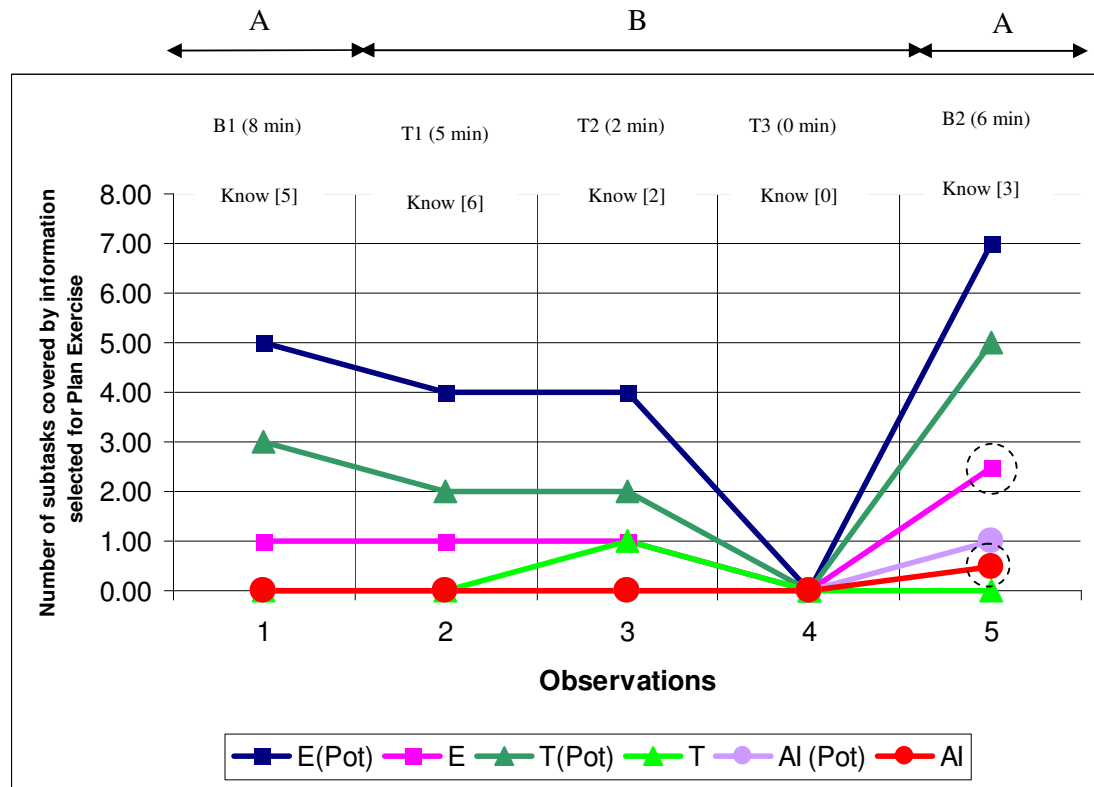


Figure 8.18 – Single Case Results: (Potential & Selected) Information by Female_03

Table 8.33 reveals the importance of information captured during the treatment phase of experiment.

Table 8.33 – Most Important Information selected during Treatment Phase

Journey	T1		T2	
Stage	Most important Information	Risk	Most important Information	Risk
Walking to Bus Stop	(AI) Pictures of crossing points [6]	Traffic Fall (irregular pavers)	(AI) Pictures of crossing points. [6]	Traffic Fall (irregular pavers)
Waiting	(AI) Bus time arrival at bus stop (e.g. countdown) [8]	No risk	(AI) Bus time arrival at bus stop (e.g. countdown) [8]	No risk

Getting on	-	Fall	-	Fall
Riding	(AI) Diagram route with picture references [6]	Get lost Fall Get off at wrong place	Asking at Rodo-PP the best way to get information. (suggested by participant) [4]	Not very risky
Getting off	-	Get off at wrong place	-	-
Walking to Hospital	(AI) Sequence of landmarks pictures [5]	There is no risk because it is too close to bud stop	“Ask, because picture are not the solution, you can get lost even if you have them.” [5]	Tired of walking
T3 (Game)	Information investigated: none		Information bought: none	

Table 8.33 shows that the participant considered the AI-type of information important and useful in different stages of the journey chain. In terms of risk she could identify a few: the risk of falling, or getting lost and problems with the traffic flow. Even so, the usefulness of AI-type information was only apparent when analysed by stage and, as illustrated in Table 8.32, it was not transferred to the selection/process of information in the return to baseline condition (B2).

8.3.3.2 Differences between Female-03 Baseline 1 and Baseline 2 Behaviours

Table 8.34 shows the main results of B1 and B2. There is a slight difference in terms of the content of the information investigated between B1 and B2. The choice of information pieces investigated has improved from Telephone Service to a more independent form of information, such as Timetable and Brasilia’s map which made a minor impact in the pattern of information processed: the percentage of essential type of information has increased (roughly 10 points). The level of the AI-type information was kept almost the same and close to nil.

Table 8.34 – Main Differences from Information Investigated and Pre-Journey information Accumulated

	Potential				Pre-Journey			
	B1	B1(%)	B2	B2 (%)	B1	B1(%)	B2	B2 (%)
TOTAL	8.00	-	13.00	-	9.75	-	11.00	-
Total E	5.00	63%	7.00	54%	6.75	69%	8.50	77%
Total T	3.00	38%	5.00	38%	2	21%	2.00	18%
Total AI	0.00	0%	1.00	8%	1	10%	0.50	5%

Table 8.35 illustrates the evolution of the differences between her Information Awareness and her Capability Awareness. The results are variable. In terms of the information awareness, a slight improvement is perceived in most of the stages of the

journey. The awareness of capability, however, can be considered to be a concept that requires more effort to be appreciated. It seems that more effort is necessary to make this participant understand the advantage of using any kind of information (the current information and the created information) to help her to execute the journey.

Table 8.35 – Differences of Capability Awareness, B1 and B2

Journey Stages	AWARENESS of INFORMATION				AWARENESS of CAPABILITY		
	B1	B1'	B2	$\Delta 1$	B1	B2	$\Delta 2$
Walk O		0.00%	12.50%	↑	6.25%	6.25%	=
Wait	100.00%	100.00%	100.00%	=	50.00%	25.00%	↓
Get On	50.00%	50.00%	200.00%	↑	50.00%	100.00%	↑
Interchange	62.50%	62.50%	150.00%	↑	25.00%	60.00%	↑
Riding	62.50%	62.50%	50.00%	↓	41.67%	50.00%	≈
Get Off		0.00%	150.00%	↑	66.67%	50.00%	↓
Walk D		0.00%	58.33%	↑	40.00%	25.00%	↓
TOTAL	68.75%	39.29%	84.62%↑	↑	37.50%	39.29%	≈

In Table 8.35, the column B' is added to simulate the total percentage (39.29%) penalising the stages in which the information awareness was not registered because the information pieces selected to compose the plan did not deliver information demanded by the stage.

In terms of attention, anxiety, risk and difficulties Figures 8.19 and Figure 8.20 illustrate the participant's behaviour captured during B1 and B2.

Figure 8.19 illustrates that the participant's anxiety level was kept the same along the whole journey to Hospital Daher (B1). The 'Walking to bus stop' stage demanded lots of participant's attention, as well as the 'riding' stage.

In Figure 8.20, it can be observed that the participant's anxiety level was variable although no great differences were observed.

In the participant's opinion (comparing Figures 8.20 and 8.2) journey B2 was considered more difficult than journey B1.

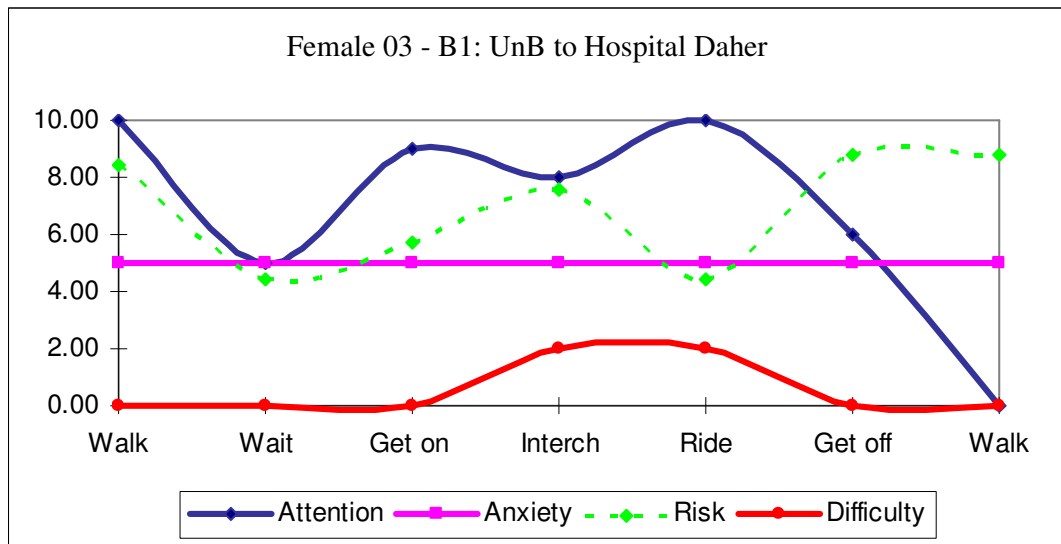


Figure 8.19 – Self Reported Attention and Anxiety Levels, plus perceived risk and difficulties, in B1.

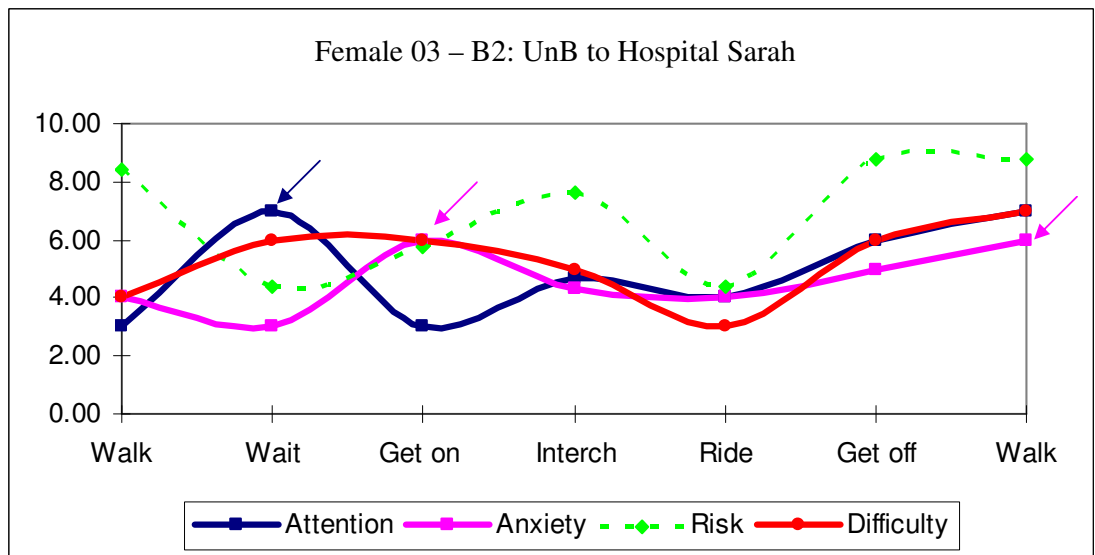


Figure 8.20 – Self Reported Attention and Anxiety Levels, plus perceived risk and difficulties, in B2.

8.3.3.3 Conclusions about Female-03 Case

In terms of the use information, Figures 8.21 and 822 illustrate that, in general, the participant's curves are below deviation recommendations in both cases, meaning that the participant should have collected and processed more information (than she actually did) in order to deal with the environment pitfalls (physical and at information level).

The exception is the '**In-Journey**' curve which shows high levels of information

‘consumption’ at the walking to bus stop stage. (Refer to Table 8.1, brief description of the journey, where the accessibility characteristics of the ‘walking to bus stop’ stage were explained).

In terms of information investigated to compose B1-plan (the bus service to go to RodoPP), the ‘**Potential**’ curve illustrates what the Telephone Service would have provided if it was working. Therefore, the surface of the ‘**Pre-Journey**’ curve reveals information extracted from memory, when the real levels of information provided were zero.

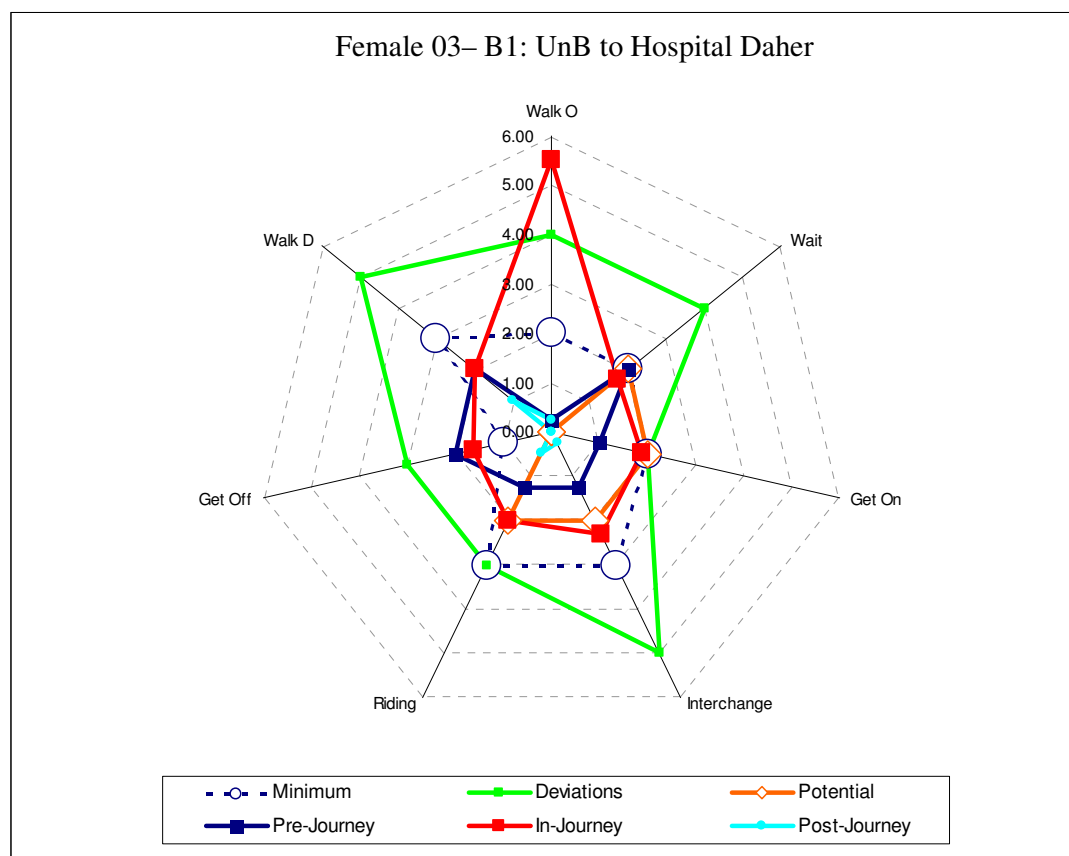


Figure 8.21 - Information Chain Dimensions, B1

In terms of performance (execution of journey), B2 was more difficult than B1 because the ‘walking to hospital’ stage was unknown to the participant.

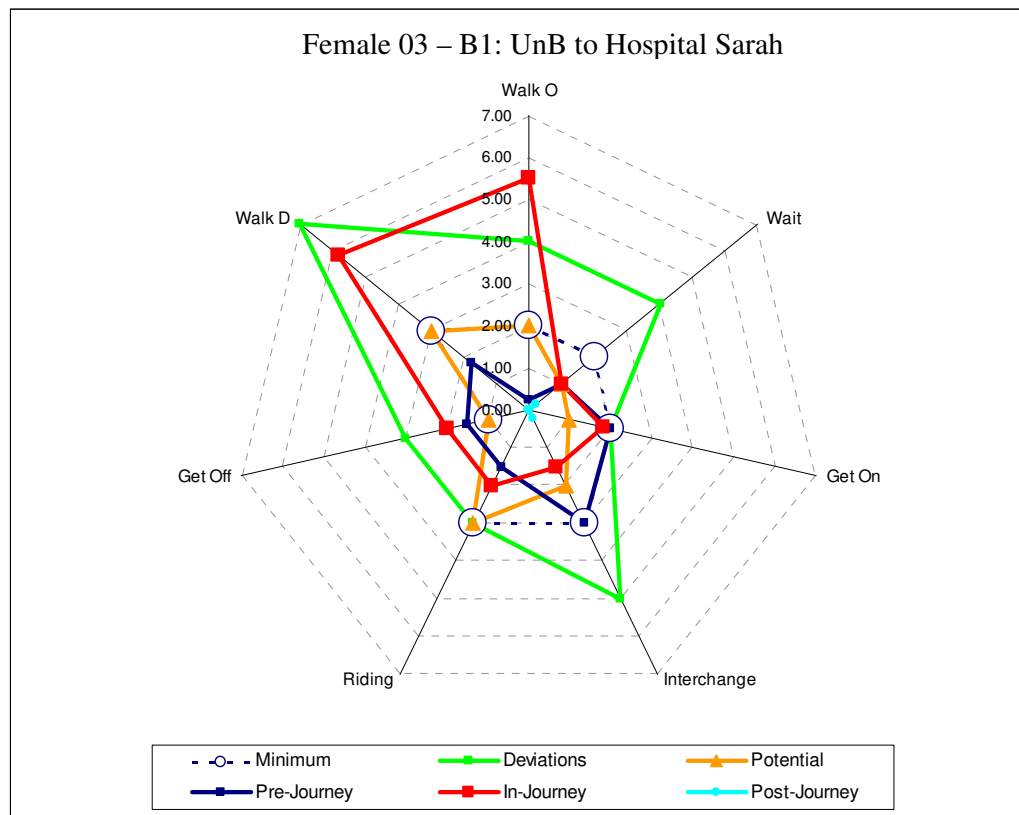


Figure 8.22 - Information Chain Dimensions, B2

In B2, the '**In-Journey**' curve illustrates the difficulties observed and reported at the 'walk to bus stop and to destination' stages. The '**Potential**' curve is below the minimum curve recommendations and the information processed before the journey ('**Pre-Journey**') is not synchronised with the '**Potential**' curve, meaning that the information from memory was activated. Some information that could have been captured by the information pieces investigated was neglected. The shapes of the curves show that this participant needs some training to make better use of the information available. Another kind of interpretation is that the information available is not suitable to help the participant. And one more type of interpretation is related to the environment accessibility levels, which are very low in Brasilia case. The exact determination and better interpretation about these interactions need further research, and some alternatives for exploring further research are presented in Chapter 10.

Concerning the usefulness of the AI-type information, it seems that although she expressed its value, in practical terms she preferred to ask people around than to look at a map-diagram or a picture-sequence. She expressed that she had difficulties in matching the information from maps or pictures to the real environment. (Refer to Table

8.33, 'walking to hospital' stage: "Ask, because pictures are not the solution, you can get lost even if you have them").

According to the practical experiment criteria, she was late for the appointment at the first real journey, but she thought she was on time. At 9:17, the appointment was fixed (by the participant) for 10:00. She arrived at the destination at 10:17, too late for the appointment (>15 minutes late). The participant's comment: "The driver was nice; he stopped just in front of the hospital. I was not paying attention, but he stopped". The participant evaluated that she had arrived on time for the appointment, despite some problems.

She has arrived on time for the second real journey. At 09:34, the appointment was fixed for 11:10. She arrived at hospital at 10:53, without problems.

Her choices are neither the best options nor the easiest ones. The extra journey to Rodo-PP in order to have access to any kind of information is unacceptable in terms of accessibility standards.

Training sections to show her the potential of each type of information piece and specific sessions oriented to self-awareness limitations might improve her planning strategy.

8.4 CONCLUSIONS ABOUT THE BRASÍLIA CASE

The methodology created to investigate how (older) people use information was applied to three participants in Brasília.

The analysis in terms of the information selection task (based on the oral and written version of the plan, the output from SCA design) does not show the process of information use appropriately. Better understanding of the participant's use of information is delivered by the additional analysis offered by the Capability Model principles, where the deviation curve (the theoretical interactions between individual capability and environment capability) puts in evidence the stages that might present problems, either because the individual is not sufficiently aware of the information

and/or about his/her own condition or because the environment is not accessible enough. The exact determination of what causes the deviation is possible but needs to be examined at a disaggregate level, per stage and more tests need to be applied exploring the environmental features of each stage. In other words: the interaction between individual capabilities and environment capabilities needs refinement per stage.

The conclusions about the INFOChain methodological procedures applied in the London case (Chapter 7, Section 7.4, items i to vi) can also be applied in the Brasilia case.

The experimental format used in the Brasilia case has suffered modifications due to the difficulties found in finding participants. The experiment was applied to one young (41 years) fit female participant with transport-knowledge background and no severe impairment and two older participants (74 and 81 years) with some mild to moderate impairments.

Some evidence points to some directions that should be investigated in further research, for example:

In general:

- i. The participants' knowledge of the information potential (what information can reveal) is weak.
- ii. The Brasilia Bus Information System is poor and inaccessible. In practical terms, the system is reduced to the bus service number and the 3-points itinerary printed at the front of the buses. Timetables and route diagrams are not accessible for the general public. The provision of public transport service information by telephone is not reliable and it takes too long to give an incomplete information;
- iii. The reduced level of information provision, the poor quality and form of the timetables and the lack of access to basic information (e.g.: simple route maps) can be considered to be barriers in the development of Information Awareness and Capability Awareness concepts;
- iv. Although, in theory, the Accessible Information Systems (i.e.: with AI-type of information) can help to enhance the Capability Awareness, the older participants are reluctant to use maps and pictures of landmarks;
- v. Participants are reluctant to use the new forms of information pieces provided by the experiment and they do not take advantage of them. However when prompted, they absorbed the information and they are able to see its benefits.
- vi. In general, the older participant's plan strategies are extremely poor;

But the older participants are happy with their strategies (considering them moderate) and they can execute the real journey exercises (even though they failed to meet experimental criteria on some occasions)

- vii. Participants are very dependent on a third person's help. The level of interactions with another person in order to arrive at destinations is very high (e.g.: boarding (get on) stage: interaction with controller, riding and getting off stages: interaction with drivers and conductors, walking stages: interaction with people around).
- viii. Participants demonstrated that they make use of some general environmental clues (constructed landmarks, bridges, lake), which help them to confirm direction.

By Participant:

- i. Female 1: In terms of the information selection, no improvement was observed. The traditional type of information was kept: localise destination, identify the service and timetable. Evidence of the use of the new AI-type information to construct the plans (B1/B2) was not observed. Selection of the AI-type of information to construct the plan was only observed in T2 but that was not translated into its effective use.
- ii. Female 2: In terms of information selected to compose plans, it seems that the current level of information provision is so low and inaccessible that this participant basically relies on her own accumulated information (e.g.: from memory). There is no visible rationality to make the plans. Evidence of the use of the new AI-type information to construct plan (B1/B2) was not observed. Selection of the AI-type of information to construct the plan was only observed in T3 but that was not translated into its effective use.
- iii. Female 3: Her choices are neither the best options nor the easiest ones. The extra journey to the main city station (Rodo-PP) in order to get some information is an unacceptable situation for any Accessible Information Systems. However this fact (the extra journey) doesn't seem to affect this participant. Evidence of the use of the new AI-type information to construct the plan (B1/B2) was not observed.

Concerning the usefulness of the AI-type information (Tables 8.11, 8.27 and 8.33), the same conclusion as stated in the London Case is perceived: it seems that although all participants think the AI_type information can be useful (value of information per stage, > 5) they are not ready to use them. Another interpretation, as suggested in Chapter 7 (Section 7.4), is that the restrictions imposed by the INFOChain experiment format (time constraint combined with not being able to take material on the real journey experiment) mask the acceptance of the Accessible Information type. A less restricted forms of INFOChain application should be investigated to analyse the reception of the new types of information within the group study.

The lack of information about bus system makes the participant create their own strategy to move around the city, among them the verbal communication with a third person seems to be a reasonable source of information for all of them even though all of them have, at least, mild impairment in following oral instructions based on spatial orientation (see Table 8.2).

As demonstrated in this chapter, some participants achieved their target destination, some did not. In practical terms, only 33% (2 in 6) of the journeys could be considered successful according to the experimental criteria (an overall analysis is presented in Chapter 9, Section 9.4).

The methodology applied in the experiment can illustrate some sources of the problems that a development of an Accessible Information System needs to tackle in Brasilia's environment, for example:

1. At users level:

- i. Resistance to using navigation artefacts (e.g.: map diagrams and picture references);
- ii. Low level education;
- iii. Solution based on minimum-effort.

2. At city level:

- i. Absence of footways;
- ii. Adverse topography (steep footways);
- iii. Long walking distances;
- iv. Barriers along walking path;
- v. Segregated city layout ("Plano Piloto").

9 CROSS-CUTTING ANALYSIS: LONDON AND BRASÍLIA CASES

Discussions conducted in Chapters 7 and 8 illustrated some differences found in the two case study environments. The results of the experiments revealed some aspects of the INFOChain methodology that should be improved and different aspects that should be treated in each city case.

In order to complement the study of the INFOChain methodology, a cross-cutting analysis was made to compare its performance between the two cities. The objective was to explore the differences in performance between the two cities and to assess the ability of the methodology to respond to different environment conditions. Two sorts of assessment are expected from this exercise: whether the experiment output responds in the expected direction and whether the quality of the responses is reasonable.

Section 9.1 presents some preliminary considerations about the general findings of this exercise. Section 9.2 comments on the conclusions reached in the London Case. Section 9.3 provides a similar commentary on the conclusions reached in the Brasilia Case. Section 9.4 highlights some difference between the two environments. Observations about INFOChain experimental criteria and experiment validity are presented in Section 9.5 and 9.6, respectively. Section 9.7 closes the chapter with concluding remarks.

9.1 PRELIMINARY CONSIDERATIONS

What is important here is to list the general findings of this exploratory exercise. They are:

1. According to the experimental outcomes the construction of a plan to do a public transport journey is not an easy task.
2. The strategies used to compose the plan are usually poor.
3. The simple availability of information pieces is not enough to change plan patterns.

Other findings are:

4. Participants use their own rationality to move around the city. This can be considered as their habits and unless the information is very accessible, easy to use and they are familiar with it (such as Countdown, route maps etc.) they tend not to use it.
5. Participants are able to find their way to complete their journey using environmental clues and interactions with people to extract information 'on line' (i.e. during the execution of the journey).
6. In the post-journey report exercise, participants tend to minimize and in some cases deny negative aspects of their performance to declare they were not late for the appointment.
7. Participants can identify difficult stages in the journey but this identification does not necessarily induce demand for more information to cover the problem.
8. Participants are able to acknowledge the utility of accessibility information but they tend not to incorporate this type information into their planning strategies. Habits and the lack of provision of accessible information induce them to repeat the pattern of their initial strategy.

These findings formalise some issues that prove valuable in the process of specifying the method to emerge from this research. First, consider the piece of evidence that to plan and do a journey by bus are not easy tasks. This task demands time and is closely related to the participant's previous knowledge in the cognitive domain (e.g. experience of the bus system, awareness and inclination to use public transport information or abilities of spatial navigation and orientation in the real environment) and there are different individual coping strategies to deal with the interactions with the environment.

Specifics about the two environments where the experiment was applied (London and Brasília) can be found in Chapters 7 and 8. The different environments were chosen so that it would be possible to compare the methodology in very different transport and information conditions. The researcher's knowledge of the two transport systems was very useful because it helped to ensure that all available information was provided in each case and, where necessary, relevant information could be created where it was not available.

Secondly, the emphasis on individual reactions showed in this study calls into question approaches that treat a participant's behaviour as if every user would have the same response to the same stimulus.

The third and fourth points can give some justification for why it is also important to investigate the participants' behaviours with non-conventional techniques. Approaches derived from social science, which are sometimes heavily criticised by technicians who are more familiar with the 'harder' sciences can be useful tools in the identification of bad habits and resistance to adopt new forms of information.

The fifth point raises doubts about the types of information provided by the current information systems and opens a discussion about the value of information systems that pursue accessibility principles but which do not cover access to the whole journey.

Finally the three last points underline aspects related to the minimization of effort of gathering information to plan a journey using public transport.

From these eight points it follows that, for the purposes of this research, the more appropriate way to describe the participants' behaviours and use of information is to focus on the individual performance, the mechanisms to understand and to explore the patterns of individual habits (how to alter it, if the alteration is considered necessary for the participant's convenience)

9.2 GENERAL IMPRESSIONS ABOUT THE LONDON CASE

Although London's city characteristics illustrate a highly dense and complex environment, its public transport system can be considered well organised with good levels of information available for both motorised and non-motorised public.

During the experiment participants showed that they believed and expected they were going to find information on the streets during the execution of the journey. At first (Baseline 1) every participant's plan was very simple. Basically, the participant extracted the bus service number that would take them to the destination target (hospitals). Further information was added during the actual process of doing the

journey, (e.g.: at the bus stop). In fact, the available printed materials at the bus stops were used to confirm and also to create alternatives to the plan for quick decisions along the journey. On the final stage of the journey ('Walking to hospital'), they did expect to find orientation-signs to guide them, however, in practice, these were not often provided. It can be said that participants counted on supportive information to the extent that they did not pay much attention to the final stage of the journey when constructing their plan. If extra information was needed they assumed that they would not have a problem in asking people around or, more often, officials such as policemen, postmen or delivery drivers. The type of questions asked in these circumstances was always about orientation to achieve sub-goals along the journey chain or confirmation about the direction towards something that was not in their visual field. No questions about accessibility issues, in the strict sense, were registered (e.g. the easiest (barrier free) or the most secure way to get there).

In terms of the incorporation of the journey chain concept into the journey planning process, only a few participants revealed improvements. There is a chance to train them to improve their knowledge during specific stages of the journey and to improve the way they move around the city, especially if they are not reluctant to use computers. The understanding of the new accessible information pieces used (colourful schematic maps - spidermaps) was not straightforward and needed to be explained.

In relation to the environmental aspects of the city, the physical environment is increasingly suffering interventions to upgrade accessibility levels (e.g.: dropped kerbs, tactile pavers, smoother footways, and more friendly information and orientation signs). On the operational side, however, bus drivers' disability awareness and parking training must improve. Among the local government's responsibilities there is still a huge job to be done with the adaptation of the bus platforms to conform to vehicle design in order to reduce the massive (and unacceptable) gaps observed during this study. The system must be integrated to justify the immense amount of money already invested in making the environment accessible for all. As Frye (1996) and Tyler (2002) have underlined, the physical realisation of the Journey Chain concept needs to be intact and cannot be broken into pieces, otherwise the desired activity will not be completed; more importantly, it will not be satisfactorily accessible. The provision of information that advises about the accessibility of the journey chain is crucial because it allows the user to plan their journey in the confidence that they will find it to be possible in the reality.

9.3 GENERAL IMPRESSIONS ABOUT THE BRASILIA CASE

Although the characteristics of Brasilia are that it is a very simple and low density environment, its public transport system is still very badly organised, with almost no level of Information Systems for the non-motorised public. Outside Brasília, in the satellite cities, the level of disorganization increases, as well as the density levels, at the same time that transport conditions decrease to a level that can be considered unacceptable for accessibility standards.

In general, the participants' quality of planning was extremely poor and economically irrational. The search for information concentrated on the first part of the journey: where to get on and which bus to board. It seems that both sides, providers and consumers, were used to a reduced level of information provision. A precarious timetable (difficult to read, poor designed and generally not available) was the only information produced by the regulator and operators. On the other hand, because of years of experience of such poor information conditions (non-existent and, if present at all, not correct), participants tend not to demand basic types of information and have to trust the operational staff (at Rodo-PP and drivers/conductors) to put information together during the journey. The interactions between passengers and operational staff were very high and constant.

In terms of experimental criteria, the incorporation of the journey chain concept for planning the journey was almost zero. No relevant modifications were observed in the strategy to construct a plan for a journey, although sometimes participants did register the value of accessible information. The journey chain concept and the importance of the information chain to achieve independence throughout the journey were not fully incorporated by participants although a slight improvement in the different phases of the experiment was observed for each participant. One possible explanation for the lack of interest in the use of accessible information was the easy layout of the city and the absence of different options for arriving at destinations.

In environmental terms, the bus service level is very low and unreliable and the network design is very inefficient and irregular, with long waiting times. Vehicles are inaccessible and visibly poorly maintained. Bus stop designs are inadequate and not

compatible with the vehicle. Footway conditions are poor with all sorts of obstacles and pitfalls.

One interesting point that can be mentioned when comparing the London and Brasilia cases is the attitude of participants. Both groups of participants started with poor to medium quality plans, emphasizing the identification of the bus stop at or near to the origin and the correct bus service to board. In the Brasilia case, improvements in the plan construction were only marginal. In the London case, however, the improvements were more substantial with a few modifications to the planning strategy observed in at least one of the journey exercises in the case of two of the participants.

9.4 GLOBAL ANALYSIS OF INFORMATION SYSTEMS PROVIDED IN THE TWO ENVIRONMENT CASES.

An aggregated analysis (using the ‘max-column’ of Tables 4.8 and 4.11) illustrates the main difference between the two environments. Table 9.1 illustrates the information levels offered in the two environments. Figure 9.1 and 9.2 illustrates the differences.

Table 9.1 – Information Provision in London and Brasília

Journey Stages	Walk Origin	Wait	Get On	Interch	Ride	Get Off	Walk Dest.	TOTAL
Ideal level of Information	8.00	5.00	4.00	6.00	4.00	4.00	9.00	40.00
Information offered London	3.40	2.70	3.00	3.50	3.00	2.00	4.70	22.30
Information offered Brasilia	2.00	2.00	2.00	3.00	3.00	2.00	3.00	17.00

Figures 9.1 and 9.2 illustrate comparisons between London and Brasilia and the respective level of Information Provision. Figure 9.2 emphasises the difference between information provision curves.

It can be perceived that neither system delivers the ideal quantity of information according to the INFOChain classification. The more problematic stages are the ‘Walking to Bus Stop’ and ‘Walking to Hospital’ stages. Proportionally, the ‘riding’ stage has the best coverage in both systems. However, this is also the stage that had demanded more attention and had caused high levels of anxiety among the participants. This can be a criticism of the attributes used to analyze this stage (landmark reference; direction; distance and bus layout/stability inside bus), given that this stage is the least

covered in terms of formal information on board the vehicle. On the other hand, information captured from the environment (through the windows) could have masked judgments. This is an important output to consider when designing further tests and training for visually-impaired people and cognitively-impaired people.

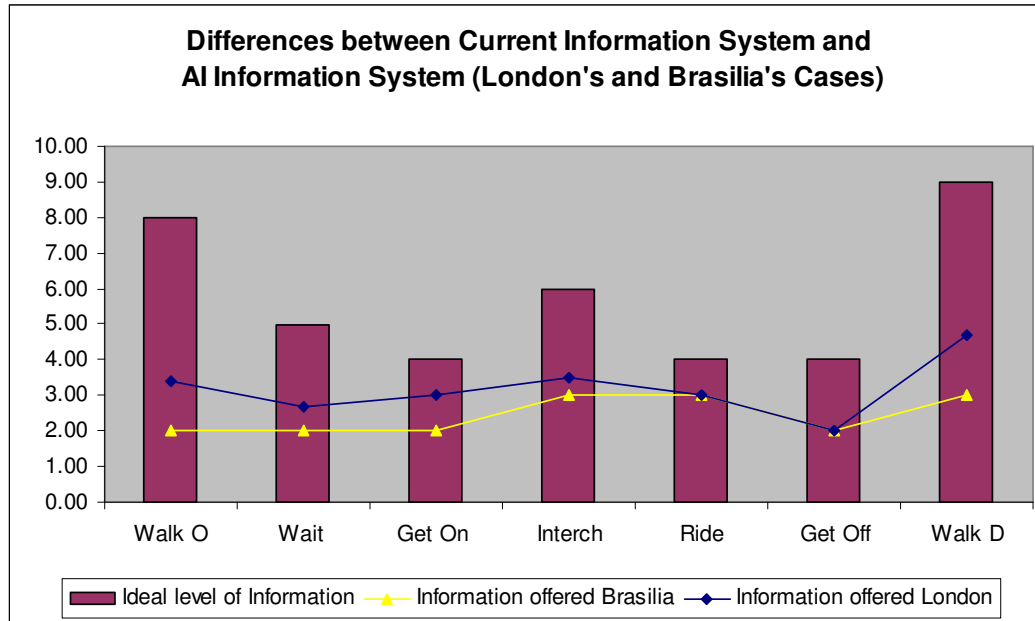


Figure 9.1 – Differences between Current Information Systems and the Ideal AI – Information Systems in London and Brasilia.

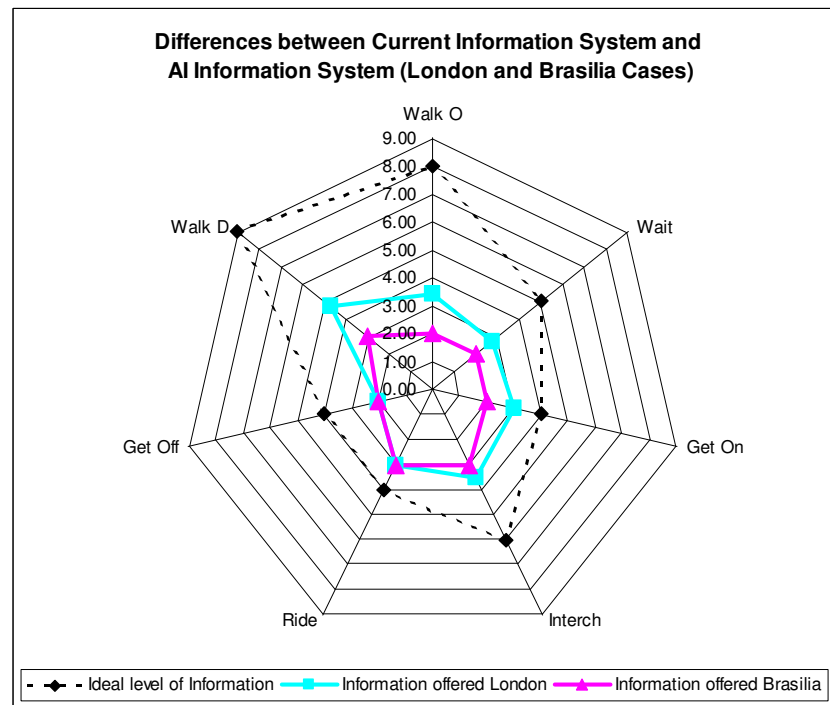


Figure 9.2 – Differences between current Information Systems and the ideal AI – Information Systems in London and Brasilia.

Another important point to consider in relation to the information pieces provided by the current bus system in Brasilia is that it concentrates on demonstrating how the system works and not how the desirable movements can be achieved. In London the information level is much better and there are some examples where the information pieces partially deliver the notion of movement, e.g.: The Journey Planner (which deals with the ‘walking stages’ and takes an intermodal approach). The information created for the INFOChain experiment introduces some attempts to demonstrate knowledge about the direction of the movement (e.g.: Radial Mobility) and the notion of macro movements between boroughs/satellite cities (e.g.: Macro-reference). An information system that could convey the logic of the city and display alternative movements (between different modes) around the city (major public services, e.g.: hospitals, libraries) might be a better way to demonstrate and improve the utility of the public transport. In parallel, the information system should be supported by a consistent and comprehensive orientation system - the ‘on line’ information used, captured by the ‘In-Journey’ curve - when all the clues from the environment might burden cognitive resources (e.g.: working memory) and affect disabled people wayfinding strategies.

9.5 OBSERVATIONS ABOUT INFOCHAIN EXPERIMENTAL CRITERIA

The study shows that although the group chosen (older people) to test the methodology can execute the journeys; some of them have failed according to the experimental criteria (Table 9.2). In London all participants could complete the activity, although with different levels of difficulty. However, in Brasília only 2 journeys were successfully completed by different participants.

Table 9.2 – INFOChain Experimental Criteria Outputs

Environment	Participant	Baseline	Experimental Criteria	ST
	Male 1	B1	<p>He has arrived at the hospital on time without problems, although he declared that he was lost in the final stage of the journey.</p> <p>The Participant requested 60 minutes just to execute the journey. The actual time taken was 30 minutes. The appointment was fixed for 16:05; he arrived at 15:55.</p> <p>The Participant evaluated that he arrived on time, despite some problems</p>	S

UK		B2	<p>He arrived at the hospital on time but not without problems, he got lost in the destination area and showed a high level of anxiety.</p> <p>The Participant requested 47 minutes just to execute the journey. The actual time taken was 35 minutes. The appointment was fixed for 15:30; he arrived at 15:25.</p> <p>The Participant evaluated that he arrived on time, despite some problems</p>	S
	Male 2	B1	<p>He arrived at the hospital on time without problems.</p> <p>The Participant requested 40 minutes just to execute the journey. The actual time taken was 23 minutes. The appointment was fixed for 12:45; he arrived at 12:35.</p> <p>The Participant evaluated that he arrived on time, without problems</p>	S
		B2	<p>He arrived at the hospital on time but not without problems, he was lucky about the waiting time and the third person's instruction in the Walking to Hospital Stage. He had to run for the appointment.</p> <p>The Participant requested 60 minutes just to execute the journey. The actual time taken was 48 minutes. The appointment was fixed for 12:00, but he arrived at 11:55.</p> <p>The Participant evaluated that he arrived on time, despite some problems.</p>	S
	Female 1	B1	<p>She arrived at the hospital on time but not without problems and declared high levels of anxiety. In reality, the journey was executed without major problems at the beginning and with assistance of the driver who was asked to help when she boarded the bus.</p> <p>The Participant requested 90 minutes just to do the journey. The actual time taken was 35 minutes. The appointment was fixed for 15:35 (14:55 if nothing wrong); she arrived at 14:45.</p> <p>The Participant evaluated that she arrived on time, without problems.</p>	S
		B2	<p>She arrived at the hospital on time without problems, making connections having used specific information (complete path from the bus stop to the hospital) she had requested, after planning, and recognised the hospital entrance from the picture.</p> <p>The Participant requested 40 minutes just to execute the journey. The actual time taken was 35 minutes. The appointment was fixed for 12:30; she arrived at 12:05.</p> <p>The Participant evaluated that she arrived on time, without problems.</p>	S
	London - Score			100%

BR	Female 1	B1	<p>She arrived at the hospital on time without problems, despite some operational struggle.</p> <p>The Participant requested 75 minutes just to execute the journey. The actual time taken 49 minutes. The appointment was fixed for 17:15 and she arrived at 17:05</p> <p>The Participant evaluated that she arrived on time, despite some problems</p>	S
		B2	<p>She failed to arrive at the hospital on time, she had to wait a very long period at the bus stop, and displayed high levels of anxiety.</p> <p>The Participant requested 54 minutes to arrive at the destination on time. The actual time taken to execute the journey was 57 minutes. The appointment was fixed for 16:40 but she arrived at 16:50.</p> <p>The Participant evaluated that she had missed the appointment, delay less than 15 minutes</p>	F
	Female 2	B1	<p>She arrived too late for the appointment (28 minutes late). Got lost in the Walking to Hospital stage, demonstrated impatience, anxiety and tiredness.</p> <p>The Participant requested 70 minutes to arrive at the destination on time. The actual time taken was 93 minutes. The appointment was fixed for 10:30 but she arrived at 10:58</p> <p>The Participant evaluated that she arrived on time, despite some problems</p>	F
		B2	<p>She refused to do the journey due to the long walk at destination</p>	F
	Female 3	B1	<p>She arrived too late for the appointment (> 15 minutes late). Misjudged the bus arrival time.</p> <p>The Participant requested 43 minutes to arrive at the destination on time. The actual time taken was 65 minutes. The appointment was fixed for 10:00 but she arrived at 10:17.</p> <p>Participant evaluated that she arrived on time for the appointment, despite some problems.</p>	F
		B2	<p>She arrived at the hospital on time without problems.</p> <p>The Participant requested 96 minutes to arrive at the destination on time. The actual time taken was 78 minutes. The appointment was fixed for 11:10 she arrived at 10:53.</p> <p>The Participant evaluated that she arrived at the hospital on time without problems</p>	S
Brasília - Score				33%

[S] Succeed, [F] Failed

Another important observation about the outputs presented in Table 9.2 is related to the self evaluation of the success/failure of the activity (the activity achievement), a very important concept in The Capability Model proposed by (Cepolina and Tyler, 2004) and The Capability Approach proposed by Sen (1993, 1999). One particular question appears: Can the ‘satisfaction’ to complete the activity be based on individual’s report?

The results of the experiment demonstrated that the evaluation of success or failure should depend on an objective assessment by an independent observer. It seems that it is difficult for the participants to acknowledge their negative performances.

9.6 OBSERVATIONS ABOUT INFOCHAIN EXPERIMENT VALIDITY

The treatment of internal validity identified by Campbell and Stanley (1963) in Chapter 2 are now considered. As suggested in Chapter 2, the nature of the study is complex and, as revealed by the experiment results, subject to each participant’s individual interpretation of the spatial problem, which needs deep investigation in order to give some possible interpretations about their individual behaviour, strategy and rationality.

The historical effect cannot be avoided due to the nature of the human ability to learn and the ability to make intrinsic metacognition inferences. It is believed that the psychological pressure (time constraint in this case) and the replication of a real activity in the real environment offset the impact of the observer in the participants’ outputs (all participants demonstrated high levels of commitment to complete the activity).

The maturation threat (change in a participant’s behaviour that is extraneous to the response to manipulations) was diminished by the application of extensive and different test procedures, before and after journeys explained, in Chapter 6 (Table 6.3), to analyse the evaluation of each participant’s behaviour during the treatment and the baseline phases.

In relation to the testing and instrumentation (inconsistency in assessment) the careful construction of the methodology explained in Chapters 5 and 6 based on structured interviews and multiple tests and the use of the same interviewer during the application of the experiment in both London and Brasilia served to minimise inconsistencies.

However, the interpretation of the outputs needs improvement, particularly at the phase where the information use was captured in the real environment. More comments are presented in Chapter 10.

Statistical treatment was not applied in this study as explained in Chapters 2, 5 and 6.

9.7 CONCLUDING REMARKS

After the application of the INFOChain experiment in the two different environments, it is believed that two basic topics can be improved among the participants: the quality of the plan with a better understanding of what information pieces could be provided and the level of independence during the execution of the journey to reduce the level of anxiety generated by the lack of knowledge about their own limitations and about environment pitfalls. The two lines of training that could promote these improvements depend on some improvements in the public transport information infrastructure, especially in network-based information systems (e.g. internet-based information). It is expected that, in the London case, the implementation of Legible London ideas will produce significant improvements at the interface stages (walking). However, bus stop environments need urgent adaptations to deliver accessible standards.

In Brasilia the problem is more complicated because the actual standards of public transport are below any modern principles of accessible transport concepts. Nevertheless, if an intelligent network is implemented (with emphasis on feeder-services to support rapid bus transit corridors), low floor buses are adopted, compatible bus stops are constructed, bus drivers are trained (especially in accessibility awareness and docking-maneuvres at the bus stops) and comprehensive Information Systems are delivered there is a chance of different types of disabled people being able to use the system with some success. Information Systems will need to cover all the journey stages to be considered accessible and information pieces need to cover all the levels of knowledge recommended by this study.

The experiment methodology was constructed at the individual level because the nature of the individual is a major element of the person-environment interaction which sets the demands for information. It is important to understand this at the individual level

before attempting to aggregate into groups of people. The importance of such studies is to deliver practical knowledge and to suggest mechanisms (e.g. the need for special training sessions to improve knowledge of the system tools and to reduce anxiety) to include more people in mainstream transport. It might be the case that the current level of information system is good enough for the majority of young working people but this study has shown that it is not very easy for older people to use. The methodology can be extended to different groups of disabled people (wheelchair users; visually impaired people; hearing impaired people and cognitive impaired people), provided some adaptations to the experiment material are developed.

Although the methodology can be applied to different levels of information system environments, the real gain of its application is at the reasonably organised environment where the minimum standards of accessibility are already implemented. It is believed that the methodology will be more effective among those with significant impairments (frail elderly people, moderate to severe physical and sensory impairments) where it can expose the impossibility of completing one or more specific stages of the journey and therefore the journey as a whole. The provision of information for cognitively-impaired people needs deeper investigation related to the mechanisms of wayfinding and independence of executing a public transport journey.

10 CONCLUSIONS AND RECOMENDATIONS

In this chapter the achievements of this research are summarised and further investigation recommended. After some general remarks in the next section, Section 10.2 assesses the extent to which the established objectives have been met. Section 10.3 comments on the conclusions reached in each of the steps outlined in Chapter 1 to verify the working question of the research. Section 10.4 suggests further research following the achievements of this thesis and Section 10.5 presents the closing considerations.

10.1 GENERAL CONSIDERATIONS

Buses constitute the main public transport mode in most cities of the world. The accessibility levels of bus systems are very variable and most of the time they reflect the importance of public transport schemes inside the hierarchy of the national public transport policies. The level of accessibility, on the other hand, is an outcome of a society's response to the needs of particular groups of the population – disabled people, older people etc, in terms of their potential use of the transport system. In some cases this is expressed in law and applied in practice, in some it is expressed in law but not applied and in some it is not part of the legislative requirement. London could be argued to be in the first category and Brasília in the second.

In practical terms, the Information Systems pertaining to bus systems seem to be the last part treated in a transport system. They are introduced after the implementation of service networks and the vehicle technology. Orientation systems, as shown by this study, are in a worse situation, in some cases they do not even exist.

There is a widespread understanding amongst researchers that Information Systems can increase the efficiency of the system and that they should be oriented to meet bus users' needs. With the development of communications technologies different information systems have become feasible, even to the extent that it is now possible to deliver personal information to users. However, the use of information and its components (content/format/media) are still based on operational roots for general and able users. In practice it is only recently, with the advent of accessibility regulations that the disabled

user has to come to be the focus of studies in London. Brasilia has a very long way to go to achieve reasonable levels of accessibility.

In order to understand the general principles of an individual's use of an information system, it is necessary to ensure that appropriate means are employed to analyse this use in real environmental conditions and to assess the needs at the level of the individual. This research represents an effort in this line. It seeks to understand how the individual makes use of information in order to complete an activity using public transport. In order to achieve this, it is necessary to find a way to understand how the individual uses information to make a journey. Ultimately, the objective is to develop a reliable instrument to analyse existing or designed information systems in terms of their use by the individual and to produce realistic measures of performance, capable of identifying weaknesses in the information system at different stages in the journey, according to the individual's perspective.

10.2 MEETING THE OBJECTIVES

The general aim of this research is defined in Chapter 1 (Section 1.2) as the provision of an instrument capable of understanding how people use the information provided and to analyse the individual's ability to use available information. That section also suggests that this work could support bus system planners in their task of analysing the design and evaluation of accessible information systems. The development of the INFOChain methodology reported in Chapters 5 and 6 and its application in two different city cases outlined in Chapters 7 and 8 constitute evidence that these general goals were reached. However, it is necessary to investigate whether the specific objectives also defined in Section 1.2 were satisfactorily met.

This research was structured around one working question "how people use transport information to complete an activity in an unfamiliar area" using the example of how older people use bus system information in order to go to a hospital at an unfamiliar location. The response to this question followed five basic steps:

1. review of theoretical models of human cognition and spatial orientation;
2. review of the specifics of the target group (older people) in relation to their use of information systems;

3. review of accessibility concepts;
4. establishment of a common frame of information analysis for the journey chain and
5. set the experiment,

whose findings are discussed in the next section.

These five steps, in turn, materialise into a set of three specific objectives:

1. To understand the user's behaviour to formulate the experiment,
2. To understand how to capture the user's behaviour in real conditions in different environments.
3. To construct an experiment to evaluate the user's ability to use accessible information.

The extent to which these objectives were met is assessed in the next three subsections.

10.2.1 Understanding the use of information to formulate experiment

The first objective of this research demanded the study of how people use information. The common assumption of transport information systems is that general operational information (e.g.: timetable and route maps) provision is sufficient to complete a journey by bus. This assumption is testable and this study started by assuming that the operational level of information provided was insufficient for supporting the different needs of different groups of people, especially disabled people.

In order to characterise the use of information, reviews of the human cognitive system, of spatial apprehension (Chapter 3) and of information system designs (Chapter 4) were made. Special attention was paid to the needs of the target group (Chapter 2, Section 2.6 and Chapter 4, Section 3.4). These reviews proved essential to the process of designing and constructing the experiment, as a standard approach could not be found in the literature. Two pilot tests were conducted to test the consistency and understanding of the experiment.

The understanding of information use was built by answering two main questions (E and F, Chapter 5, Section 5.2):

(E) Has knowledge and the continuous provision of information about accessibility issues improved the participant's ability to execute a planning strategy? (Discussed in Chapter 7 and 8)

(F) Is the environment condition (which should be reflected in information system) limiting the activity? (Discussed in Chapter 9)

The review and the pilot experiment helped the assessment of what should be included in the experiment, what should be improved (e.g. risk assessment) and what could be left out (e.g. subjective representation of efforts). Thus, the objective is considered to have been met.

10.2.2 Capturing User's Behaviour in Real Conditions in different environments

In Chapter 2 it was determined that the comprehension of information use needed to be addressed in real conditions, with interactions with real environment objects and scenes. The problem with traditional approaches of spatial task tests (in a laboratory, in a closed and virtual environment) is that they tend to avoid interaction with the real environment because of the need to avoid 'uncontrolled' externalities. Therefore it was necessary to develop a procedure capable of coping with the real nature of the interactions between an individual and the environment, and of delivering results that allow the assessment of the actual features of the problem.

In order to address this problem, Chapter 2 argued that Single Case Analysis (SCA) would be the most appropriate methodology to capture the information required to assess the use of information, but that this should be adapted by adding the concept of the Capabilities Model (CM) (which explores interactions between individual and environment) and quantification of awareness. This combined SCA/CM approach was then employed in this research so that it could take into account the deep individual observations as they are subject to real environment conditions (Chapter 2, Figure 2.4). This objective, therefore, was generally met, as detailed in Chapter 5 and 6.

10.2.3 Constructing the experiment to evaluate the ability to use (accessible) information

The description that resulted from the review and pilot tests was also successfully translated into the appropriate selection, modifications and improvements of some tasks in the experiment.

Of particular relevance is the participant's ability to comprehend and execute the tasks and the duration of the experiments. Among the adjustments suggested by the pilot test application were: the adequacy of the tasks proposed; the improvement of risk assessment task and the modification of one of the real journey destination to enhance the quality of outputs during the planning and execution of the journey.

10.3 CONCLUSIONS

The working assumption of this thesis is stated in Chapter 1 and is that:

Depending on the level of information provided to a specific user and the level of information he/she can process, the task ('do a journey' by bus in an unfamiliar environment), can, in principle, be possible (easier) if the transport (including information) system is accessible and the user knows how to use it (how the mode works and how to put information about it together)

The working hypothesis, therefore, was:

Information about accessibility issues can help older people to construct a better plan and consequently successfully complete the journey.

In order to test this hypothesis, a four-step path was outlined in Chapter 1 (Section 1.2). The next four subsections summarise the findings related to these steps achieved in the course of this research. The fifth subsection draws the research's general conclusions.

10.3.1 Build up a Theoretical Schema to orient the experiment procedures (item i, Section 1.2)

The review focused on three specific aspects of relevance: generation of cognitive maps, representation of knowledge and the specifics for the target group (older people)

This review aimed at verifying whether available tools satisfactorily represent information use and, if not, whether they could help identify possible lines of research on which this representation could be implemented. No existing conceptual model or procedure was found that satisfactorily represents the use of information but different approaches from different lines of research (mainly psychology and geography) were found that could be used to assemble a theoretical schema to support the construction of an experiment that was reliable but, at the same time, flexible enough to deal with an individual interacting with real environment conditions (Figure 3.6, Chapter 3).

10.3.2 Institute a Common Framework of Analysis: Information Chain Attributes (items ii and iii, Section 1.2)

The objective of this step was to establish a common frame of analysis for the whole process of information use throughout the journey. The literature review and the outputs from pilot tests contributed to the analysis of accessibility issues along the journey chain and to the establishment of the attributes that would affect information use. Forty different attributes were identified that were considered to quantify and qualify information use (Table 4.6, Chapter 4).

The same set of attributes along the journey chain was fixed and used to verify individual capability provision and environment capability requirements in each journey stage and to quantify the Information Awareness and the individual Capability Awareness that represents the amount of information an individual is actually using and the potential information that s(he) could use with a better understanding of the accessibility issues involved in a journey by bus.

10.3.3 Construct the experiment procedures (item iv, Section 1.2)

The development of the proposed INFOChain methodology/experiment covered three aspects of information use at three different moments:

1. Before-journey (investigating the selection and processing of information pieces);
2. During the journey (with the actual use of selected and processed information, plus the information absorbed from the environment) and
3. After-journey (with evaluation of anxiety levels generated, attention level required and evaluation of task performance).

Different approaches and levels of detail were used in this task. This can be explained with the help of some previous figures and tables: Chapter 5 (Figure 5.1, Figure 5.2 and Table 5.1) and Chapter 6 (Table 6.1, Table 6.2 and Table 6.3) and Figure 10.1 guided by the next Section 10.3.3.1.

The methodology proposed is centred on different ways to quantify information along the journey: the individual's use and awareness of information. Many of the innovative trials suggested need to be tested more extensively (amplifying the sample size) in order to be considered valid and reliable. Precautions were taken to make these points clear when a new test was proposed by the researcher (Chapter 5, Section 5.4.8 – Place Cognition Test and Section 5.4.11 – Risk Perception and Risk Behaviour and Chapter 6, Section 6.2.1.1 - Baseline Observations: The Before Journey Assessment Tasks – Token Manipulation Test). They are part of the set of tests used to capture the individual's knowledge, feelings and behaviours. They are then used as one of the different ways to capture spatial knowledge, affection and processed knowledge respectively before the journey.

In his research Sternberg (1999, p: 21) underlined some themes on the review of the major ideas in cognitive psychology studies. Among them, one is concerned with the validity of causal inferences and ecological validity: “Should we study cognition by using highly controlling experiments that increase the probability of valid inferences regarding to causality, or should we use more naturalistic techniques which increases the likelihood of obtaining ecological valid findings, but possibly at the expense of experiment control? “ He also added: “We may use empirical methods for gathering data and interpreting hypotheses but we may use rationalist methods for interpreting

data, constructing theories and formulating hypotheses based on theories. Our understanding of cognition depends when we consider both basic research into fundamental cognitive process and applied research regarding effective uses of cognition in real world-settings.”

Sternberg’s argument is brought up not to excuse the current limitations of INFOChain Methodology but as evidence of the methodology opens space for some important research areas which have not received much attention within the transport field.

10.3.3.1 INFOChain Methodological Perspectives and Use

The INFOChain methodology was assembled to investigate the impacts of the individual’s ability to deal with information (select/process/use) in order to plan and execute a journey by bus in the real environment, verified by the application of different types of questions and tasks.

Chapters 7 and 8 show that the INFOChain experiment can identify the capability level with which an individual will start a journey; the environment capability required to execute a journey, possible pitfalls that this individual will find along the journey and quantify awareness of information and awareness of capability this individual presents.

Figure 10.1 illustrates that the inputs required by INFOChain to help this analysis are: the Battery Test in order to understand particularities of the individual (individual capabilities, Section 5.4 and 5.5, Chapter 5) and the Journey Environment Inventory to evaluate the (accessibility) level of the environment (environment capability, Sections 5.6 and 5.7, Chapter 5). These are then compared and the output of this comparison is the Deviation Curve (the predictive tool which identifies possible pitfalls this individual will find along the journey). Sensitivity analysis is suggested for the calibration of the Deviation Curve through the formal introducing of subjective variables, such as: the individual levels of knowledge, risk and anxiety.

The actual analysis of how an individual uses information is based on SCA/CM format, (Chapter 2 and Chapter 6). The Before-Journey analysis concentrates on capturing the participant’s selection and processing of information to plan the journey. It also

constitutes part of the baseline condition of the first real journey exercise which delivers evidence of the natural strategy to compose the plan to execute the journey.

For the subsequent phase, the treatment, three virtual journeys were introduced to improve awareness of accessibility issues and give the opportunity to the participant to use more and different types of information. Risky stages and the importance of information were captured. The effect of the treatment was then evaluated by the return to baseline condition and for that, the second real journey exercise was proposed and another journey inventory was carried out. The whole experiment took into consideration the individual's metacognitive impressions, constantly assessing them about the quality of their plans, performances and the difficulties and the feelings about the tasks projected.

The outputs of the INFOChain applications are both objective (journey curves) where it is possible to identify the difficulties along the journey chain and subjective (acceptance of AI-type information, self reported attention and anxiety levels, performance evaluation and perceived difficulties) which together explain the coping strategy adopted in the execution of the activity. The objective and subjective outputs can be used to define the training needed to improve the participant's independence and as an evaluation of the improvements achieved during training.

On the other hand, Chapter 7 and 8 also suggested that the format of INFOChain experiment (time restriction combined with the impossibility to take information during the real journey exercise) might have affected the outputs of the experiment (the individual's ability to use accessible information). The treatment phase of the experiments suggested that the participants (in both environments tested) evaluated the AI_type of information as important (>6 , in London and >5 , in Brasília) although the recognition of this importance was not transferred to the final phase of the experiment (the second real journey exercise) as expected.

The analysis of participants' behaviour and their commitment in finishing all the phases of the experiment (expressed during the oral interviews and by the coping strategies tables) raised a question about the weight of the time constraint imposed by the experiment. The current format of the INFOChain experiment seems to over pressure the participants and restricted their selection of information because it did not give them

enough time to evaluate the new kind of information neither gave them a chance to test AI_type information in real conditions. New formats of INFOChain applications and a relaxation of the time constraint are suggested to calibrate INFOChain experiments. Specific studies about the effect of time pressure on information selection are suggested for further application of the INFOChain methodology.

10.3.4 Possible Different Uses of INFOChain

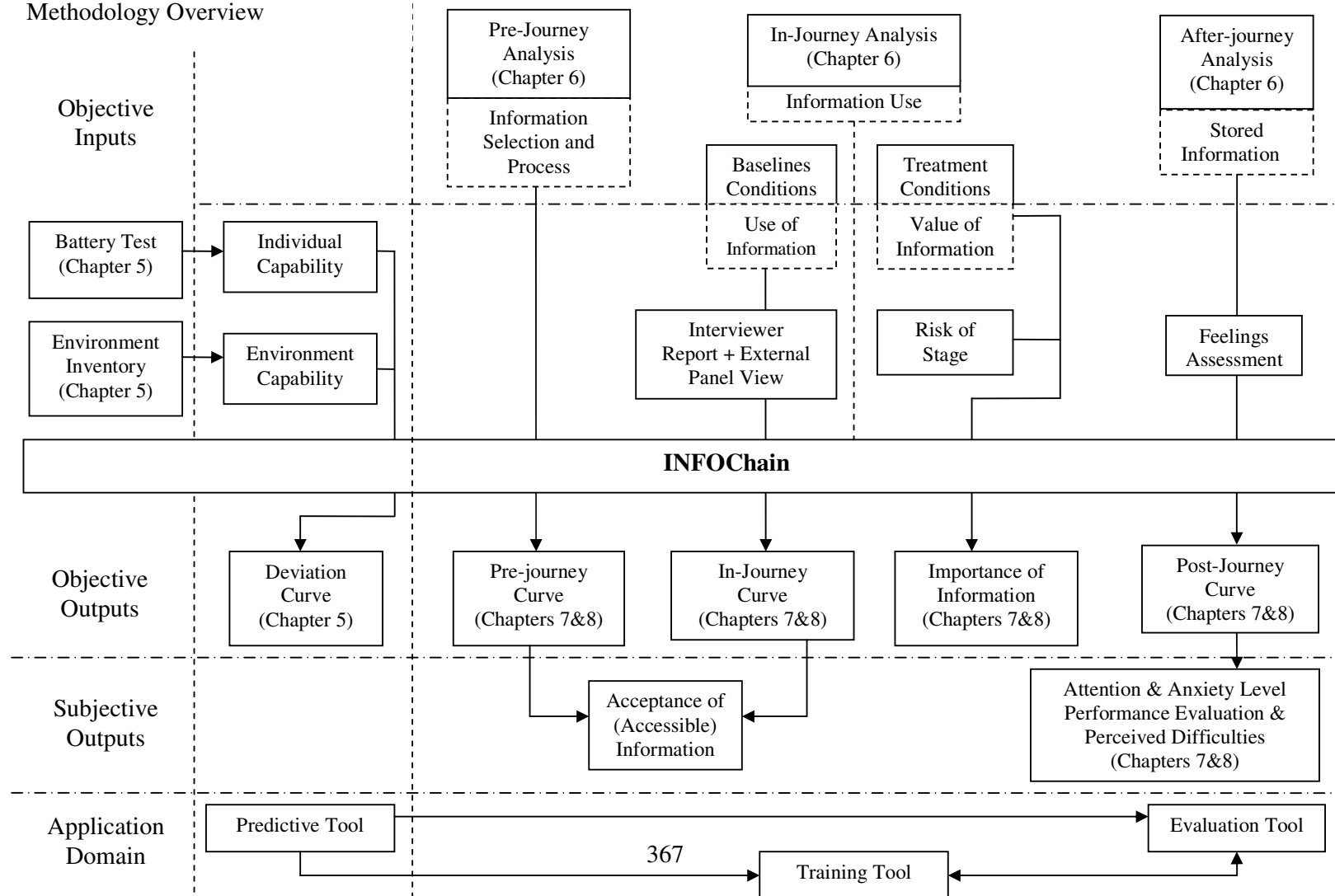
The proposed methodology of INFOChain is flexible and can be used in different environment conditions with different levels of detail. The main factor determining these differences is the use to be made of the methodology, e.g.: as a predictive tool; as a training tool and as an evaluation tool, as illustrated in Figure 10.1.

As a predictive tool: capturing individual capability provision and comparing with the environment capability required;

As a training tool: teaching target groups to take advantage of accessible information and improve their individual strategy to stimulate independent behaviour;

As an evaluation tool: comparing evolution of individual strategy and improvements during different journeys and adjust training procedures.

Figure 10.1 – INFOChain
Methodology Overview



10.3.5 Concluding remarks

The first and most important remark to be made in this subsection is a general conclusion for this thesis. The findings discussed in the previous subsections of this section raised some reservations about accepting fully the working hypothesis as formulated in Chapter 1 (Section 1.2). In other words, the research does not entirely confirm that accessible type of information can help older people to construct a better plan.

A number of other remarks are necessary to highlight the characteristics and limitations of INFOChain as it is in the current stage of development.

Although INFOChain has been designed to explore accessible information, the focus was on how (older) people use it. In that sense, the individual was really the object of this study. As a result, the use of accessible information was subject to the individual's knowledge of and familiarization with information, plus the accessibility maturity level of the environment included in the study. That explains the reasons why the hypothesis was not fully proved: It is necessary to have more than a single exposure to accessibility type information to actually be able to use it, or better, to take advantage of its design. INFOChain has shown that even for the London environment in which the accessibility issues are already incorporated in the system (at different levels), the target group had some difficulties in understanding the purpose of some pieces (e.g.: spidermap) or using its digital version (e.g.: Journey Planner). This also highlights the importance of training older people and intensifies the dissemination and comprehension of accessible information systems.

The INFOchain practical experiment has the advantage of putting the person in the study into a real life condition (with all the limitations explained in Chapter 5 and the criticisms raised in Chapter 9, Section 9.4), systematically exploring his/her behaviours and using them to calibrate his/her ability to use information. It is worth explaining that this “feedback” of performance was not formally given back to participant but the participant could feel their progress and limitations during the experiment assessment (due to recurrent metacognition assessment). In fact, excellent levels of personal commitments were observed among the participants in the sense of adjusting their plan and orientation in real conditions and even trying a few new types of information.

The flexibility of the INFOChain design is another issue that must be mentioned in this subsection. In principle, INFOChain can be implemented in any environment keeping the same principles and the same levels of comparison between different settings. In the last instance, it can reveal how appropriate or not a transport system is for different groups of people who wish to complete their common activities or, in a more strict vision, how the activity in that environment (or the means to achieve that activity, the transport mode) might impose constraints on the accessibility for that individual.

Finally, it must be stressed that INFOChain was written in such a way that the resources introduced specifically to cope with the representation of bus mode interactions could be easily adapted for other modes and different groups. On the other hand, the limitation of using more advanced devices from psychophysiology/neuropsychological field must be overcome in future versions of the experiment, to address important feelings such as anxiety and attention, which were only touched in this study via subjective self reported manifestations.

10.4 RECOMMENDATIONS

The recommendations for work to follow this research are divided into three parts. The next subsection discusses possible follow-ups in the development of INFOChain. Subsection 10.4.2 discusses ways to improve the subjective measures of feelings employed in this research. Finally, subsection 10.4.3 suggests new themes for research, related to, but not included within the limits of the methodology treated in this thesis.

10.4.1 On INFOChain

In Chapter 2, it was acknowledged that the target group would concentrate on older people because the need was to fix the parameters to build up a methodology to use in real life conditions. Therefore older people were chosen as participants to avoid the need for special production in information design, or special devices that were not pre-installed on the mainstream system and to avoid the need for an escort.

Now with the results obtained, one possibility is to explore how older people could be trained to take advantage of information provided in order to improve their independence levels, provided they want to improve spatial/wayfinding strategies. One

possible way is to extend the period of treatment with more virtual journey analysis and also to change the format used to present the information pieces: the game format seems to help people to decide because all the possible combinations of information are right in front of them. The Token Manipulation exercise was considered to be a good way to understand strategies used to plan the journey. It can also be used to improve poor strategies.

Another possibility is to extend the application to other disabled groups of people with the proper adaptations (e.g.: tactile maps, special communication and third person participation). Results from the analysis (Chapter 7) have suggested that the INFOChain methodology is more sensitive to people with low individual capability (high impairment levels) meaning that the methodology could be more helpful to address their problems because it can show clearly where the deviations are (the unbalanced relation between the individual's capability provision and the capability demanded by the environment).

During the experiment application it was also perceived that the less accessible an environment is, the more difficult it is to make the participant improve his/her strategy, to accept new forms of information or to make him/her understand that he/she has the right to have a fully accessible transport system (including the information system).

It is believed that an introduction of formal feedback procedures, in the training programmes, exploiting the participant's performance and feelings could help to improve individual capability awareness. Procedures dealing with the participant's self-reported feelings should be supported by neuropsychological tests and psychophysiology techniques (for example, the application of neuropsychological (psychiatric-diagnostic line) tests to measure anxiety (State-Trait Anxiety Inventory for Adults, Spielberger, 1983) combined with methods of online assessment of activity in the autonomous nervous system, such as changes in heart rate variability and by changes in the mean level of skin conductance (Storm, 2005), electrodermal activity, respiration, electrocardiogram (ECG) and eye blink rates, psychophysiology techniques (Strauss, 2005))

The INFOChain methodology seems to be potentially beneficial for before and after intervention analysis and particularly useful for the Brasília case with near

implementation of accessible bus system design (“Brasília Integrada”); and, in the London case, after Legible London standards were fully implemented.

10.4.2 On subjective measures of feelings

Because this study is ultimately centred on the individual, the correct assessment of their feelings is considered to be important. In INFOChain, the approach was to use different questions to test constructs at different times, frequently, and to assess their feelings on subjective scales. Valuable techniques and methods of assessment of problem-solving questions were taken from psychology, geography and human-machine-interaction lines of research to assess coping strategies and feelings. However, due to time/resources, the restrictions imposed by the psychology licensing boards and the lack of familiarity with neuropsychological and psychophysiology practices, the objective measurements of feelings, that could have enriched this research, were not possible. It is believed that the introduction of techniques that could, for example, monitor heart rate and respiration or measure skin conductance in real open environment conditions would add great value to the methodology improving capability awareness and augment the metacognition concept into (potential public transport) users’ training procedures to take advantage of (accessible) information systems. However, clear criteria are needed to be established first: the devices to measure body responses need to be linked with some of the subtasks of the activity which needs to be demonstrated (or to reassure a previous hypothesis). For example: measure stress levels using skin conductance to determine if the lack of supportive information inside a bus (riding stage) is related to the individual’s reported anxiety level, that is suspected from previous self reported data to be high, but where there is no corroborative objective evidence to support the self-reported contentions. Moreover there is a need to quantify what is ‘high’ and what are the tolerated levels of anxiety, in medical terms.

An additional important aspect with the incorporation of neuropsychological/ psychophysiology measurements is to study aspects raised by Merikle (2001) to explore the ways in which stimulus information perceived without awareness influences conscious experience.

The recommendation in this subsection is that these procedures should be incorporated in order to improve reliability of feelings assessment and effectiveness of training and

improvements in the use of accessible information for disabled people. There is also a need to insert the feelings formally into the analysis curve dimensions. One possible way to do this is to extend the number of individuals tested, define membership functions of risk and experience or knowledge (for example, as a set of parameters for before journey analysis) and membership functions of attention and anxiety (for example, as a set of parameters of after journey analysis) and use fuzzy logic analysis to introduce feelings into journey curves. These could then be used to generate possible variations of journey-behaviour-curves (with emphasis in the deviation curve and its prediction capacity) based on feelings.

Another important topic to address is the size of the sample. In INFOChain the focus was deep individual analysis. At the current state of knowledge, INFOChain procedures can be reduced (Battery Tests and the tests used to verify selection and process of information), the journey could be analysed by stage and the number of participants could be expanded to allow incorporation of statistical tests so that recommendations related to environment conditions and accessibility issues could be identified and the prevention or exclusion of specific groups of people could be quantified, allowing specific comments about the causes of the exclusion or of the dependence.

10.4.3 Further research

As discussed in Chapters 2 and 4, many studies report the importance of accessible transport system and accessible information systems. Acts and regulations are written to deal with this problem in general, but the actual translation into good practice is not fully observed. This thesis studied the behaviour of older people using information to complete an activity using the bus mode. What is necessary now is to expand the sample including different types of disabled people or people that are in disadvantaged conditions.

One possible way to do this is to work is to apply the concept of the INFOChain methodology in two stages. The first stage would assess the individual under real-world conditions as proposed by INFOChain (using a reduced version of the experiment) and thus would identify the difficulties the individual has in planning (working out a strategy) or/and in executing a journey. After the difficulties have been identified, the second stage would concentrate on examining the specific difficulties found in each

stage. Therefore a set of specific tests related to each stage would need to be constructed and assembled. Using the same principle, testing different groups of disabled people (with the proper content/format/media alterations) might enrich the interpretation of outputs. Another way to do this is to pre-select individuals with the same specific condition (the definition of the condition parameters and the task to be tested needs some research – psychological/medical literature review). Yet another way to study individual and environment interactions is to replicate part of the real environment condition in a laboratory to achieve more control of the environment conditions, thereby allowing concentration on the individual outputs related to specific given stimuli (the traditional way used in psychological experiment but enriched with better environment replications).

Another suggestion for further research is related to the individual awareness of the environment: the relation between the set of information accumulated to do the journey (Pre-Journey) and the set of information used to do the journey (In-journey). However better procedures must first be established to capture the use of information in the real environment (i.e.: procedures which are more accurate than the self-reporting or the shadow-reporting used in the present work). The improvement of environment awareness can be used to test the information efficiency of the system, for example.

10.5 FINAL REMARKS

This research was designed as a contribution to the understanding of bus information system use in real conditions.

The main product of this research is a methodology to follow the use of information along the journey chain – the selection of information to construct a plan, the organization of information to produce the plan and the definite use of information during the journey by bus.

The methodology can be used to help the assessment of transport service quality in relation to accessibility levels; to help the improvement of training disabled people to take advantage of information systems related to transport services. The research underlying its production opens a number of opportunities for further research, both in

the design of information system information for different groups of people and in the training procedures to include more disabled people in the mainstream transport. Comprehensive procedures can be generated from the integration between INFOChain and neuropsychological/ psychophysiology measurements to enforce the quantification of the feelings that can affect the use of information and independence.

Efforts can be oriented to answer some remaining questions:

1. Is it worth an attempt to improve users' strategy when they can 'apparently' execute the activities (move around the city using public transport) relatively well according to their own level of knowledge and when they are happy with their strategies? What is the effect of habits on such judgments? What levels of dependence are they accepting?
2. If the individual's plan strategies are so poor and the moving phase of the journey demands lots of resources (physical/sensorial/cognitive), would it not be better to concentrate on delivering an orientation system that can reduce effort, supporting the 'in-movement' phase, improving information according to the city logic, providing access to essential public services?

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ANNEXE A.1 - PART A
INFORMATION FEATURES AND ENVIRONMENT
THE LONDON CASE

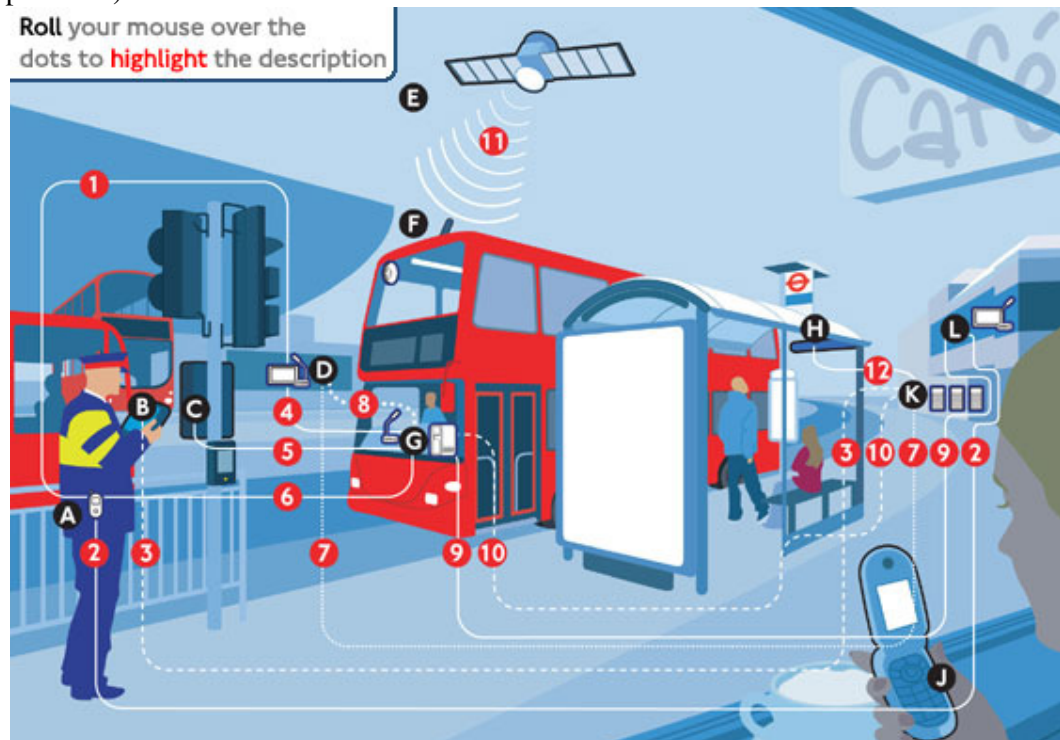
PART A – THE LONDON ENVIRONMET: Bus Information System available along the journey chain:

Table A1.1 – The Actual Environment: Accessibility conditions in London

	
<p>Figure A1.1 - Footway Conditions, Thomas Doyle Street, South East London</p>	<p>Figure A1.2 -Footway conditions and Bus Stop detail, South East London</p>
	
<p>Figure A1.3 – Crossings at London Road, South East London</p>	<p>Figure A1.4 - Footway conditions and Bus Stop detail, North West London</p>
	
<p>Figure A1.5 - Footway Conditions, near Royal Free Hospital, North London</p>	<p>Figure A1.6 – Orientation Signs, near St. Bartholomew Hospital</p>

Photos were taken by the researcher.

Figure A1.7: The Conceptual 'iBus' System (Not present at the time of INFOChain Experiment)



A	On street controller – hand portable radio	1, 2, 6	MPT1327 (standard for analogue trunked radio system)
B	On street controller – hand held computer	3, 10	General Packet Radio Service (GPRS)
C	Traffic light priority control	4	MPT1327 (standard for analogue trunked radio system)
D	Bus garage	5	Two-way wireless radio
E	Satellite	7	Virtual Private Network (VPN)
F	Bus Global Positioning System (GPS) receiver	8	Wireless Local Area Network (WLAN): Close Circuit TV (CCTV) and traffic enforcement camera download. Data provisioning up and download
G	London Bus with: On board computer, voice and data radio, next_stop sign and audio announcement, Close Circuit TV (CCTV), bus priority, camera/traffic enforcement	9	MPT1327 (standard for analogue trunked radio system) – Code Red
H	Bus stop Countdown information	11	Global Positioning System (GPS)
J	Mobile phone passenger information	12	General Packet Radio Service (GPRS)/Integrated Services Digital Network (ISDN)
K	Central System		
L	CentreComm		

Source: www.tfl.gov.uk

Table A1.2 – Information in the Walking stage: Legible London Proposition (Not present at the time of INFOChain Experiment)




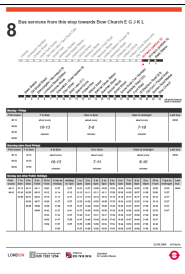

 <p>Just some of the varied pedestrian wayfinding systems in central London. Please refer to Appendix B for a detailed audit of these sign systems.</p>	<p>Living Map Architecture The system would deliver maps for media and city-wide signs. It would also deliver a digital management tool for use by bodies responsible for information in the street.</p> <p>Planning tool Utilising placement methodologies, signage planning would be coherent and effective.</p> <p>The map would be available in a variety of scales.</p> <p>Detailed area scale</p> <p>City overview scale</p> <p>Core data Digital mapping software would store names, locations and destinations according to a London-wide agreement of criteria. The software would be updateable and managed.</p> <p>Map outputs Master artwork provided for different media and street sign measures, including all information on signs.</p> <p>Walking maps</p> <p>A-Z maps</p> <p>Transport interchanges</p> <p>Digital devices</p> <p>Online & Journey planners</p> <p>Pedestrian & tourist maps</p> <p>On-street</p>
<p>Figure A1.8 - The situation: There many orientation pieces of information without common standards, not efficient, sometimes inaccurate and difficult maintenance conditions.</p>	<p>Figure A1.9 - The proposed solution: integrated and standardized system consistent but flexible for scale and use.</p>



Table A1.3 – Information in the ‘Waiting’ stage: Information at bus stop

		
<p>Figure A1.10– Bus Stop Sign: line services at bus stop</p>	<p>Figure A1.11 – Countdown: time arrival estimation</p>	<p>Figure A1.12 – Timetables: schedules and routes</p>
		
<p>Figure A1.13 – Route Maps: schematic routes</p>	<p>Figure A1.14 – Local Bus Map: service lines and place of interest</p>	<p>Figure A1.15 – Spider Map: schematic routes</p>

		
<p>Figure A1.16 – Where to catch you bus</p>	<p>Figure A1.17 – Timetable example Source: www.tfl.gov.uk</p>	<p>Figure A1.18 – Spidermap examples Source: www.tfl.gov.uk</p>


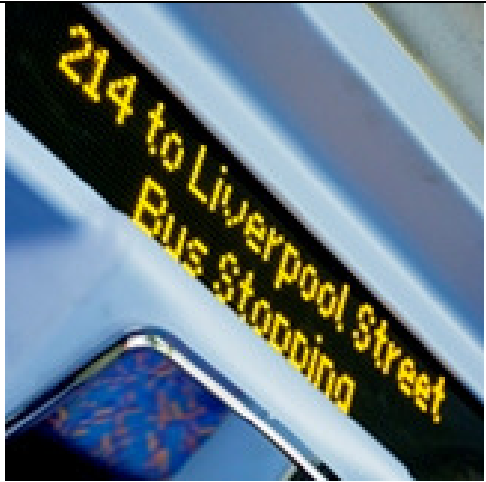
Photos were taken by researcher.

Table A1.4 – The ‘Getting On’ and the ‘Getting Off’ Stages: Examples bad and good of horizontal and vertical gaps situations.

	
<p>Figure A1.19 – Bad Gap Example</p>	<p>Figure A1.20 – Good Gap Example</p>

Photos taken by researcher.

Table A1.5 – Information in the ‘Riding’ stage (inside bus), at the time of INFOChain Experiment

	
<p>Figure A1.21 – Inside an articulated low floor bus</p>	<p>Figure A1.22 – Visual System Message</p>

Photos were taken by researcher.

ANNEXE A.1- PART B
INFORMATION FEATURES AND ENVIRONMENT
THE BRASÍLIA CASE

PART B - THE BRASÍLIA ENVIRONMENT

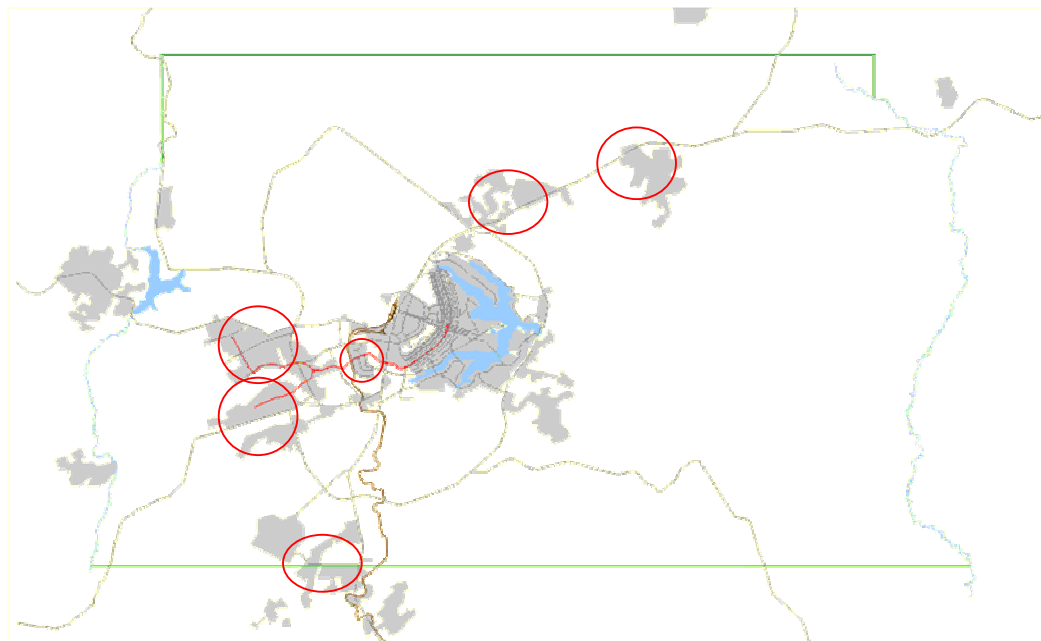


Figure B1.1a– Brasília and satellites cities, GDF (2006)

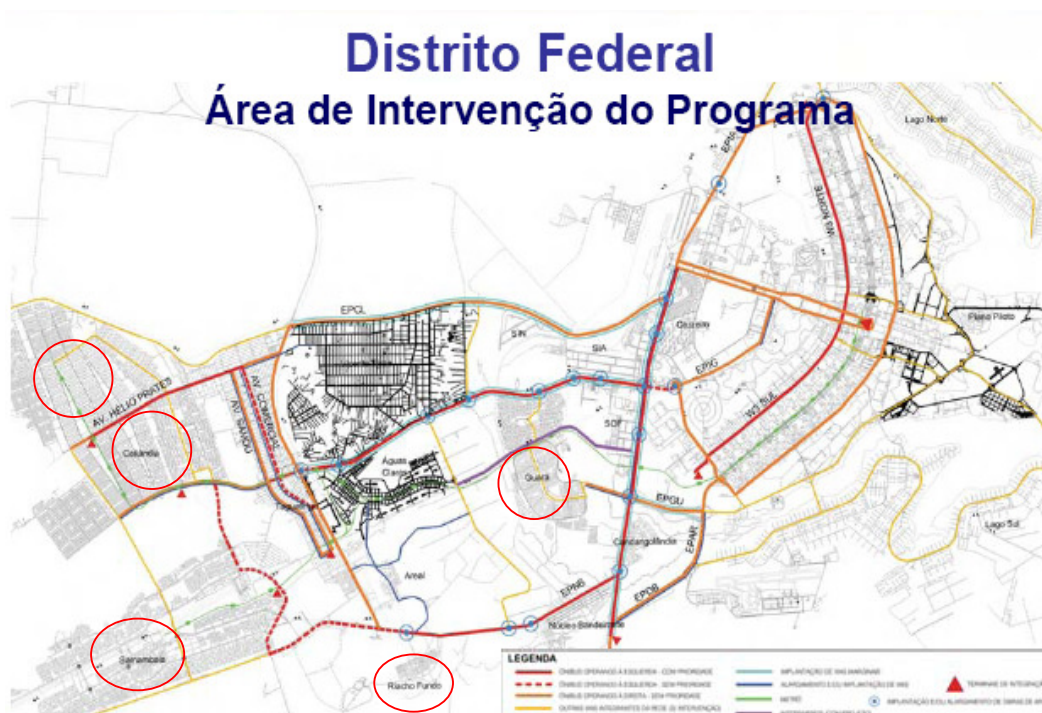


Figure B1.1b – Intervention Area: Brasília site and RIDE area (satellites cities), GDF (2006)









PART B – The Brasília Bus System Information Available along the journey chain

Table B1.1 – The Actual Environment: Accessibility conditions in Brasilia Plano Piloto

	
<p>Figure B1.2 – “Footways” at city blocks (Carvalho, 2003)</p>	<p>Figure B1.3– Bus Stop condition (Carvalho, 2003)</p>
	
<p>Figure B1.4 – Bus Stop at L2 Norte (used as parking space)</p>	<p>Figure B1.5 – Bus Stop at W3 Sul (Carvalho, 2003)</p>
	
<p>Figure B1.6– RodoPP at peak hour (Carvalho, 2003)</p>	<p>Figure B1.7 – Access to Bus at RodoPP</p>
	
<p>Figure B1.8 - Saturation at RodoPP (GDF, 2006)</p>	<p>Figure B1.9 – Pedestrian doing ‘Life Signal’ at Zebra Crossing</p>

Photos were taken by the researcher.

Table B1.2 – Accessibility conditions at the Satellite Cities

	
<p>Figure B1.10– Footways with steps at Nucleo Bandeirante</p>	<p>Figure B1.11 – Sequence of obstacles in Taguatinga to access a Hospital</p>
	
<p>Figure B1.12 - Taguatinga</p>	<p>Figure B1.13 - Taguatinga</p>
	
<p>Figure B1.14 - Taguatinga</p>	<p>Figure B1.15 - Footways conditions at Sobradinho</p>
	
<p>Figure B1.16- Av. Helio Prates – Ceilândia. Bus Stop invaded by street sellers (GDF, 2006)</p>	<p>Figure B1.17 - EPIA – No footways along roads, no priorities for buses. (GDF, 2006)</p>

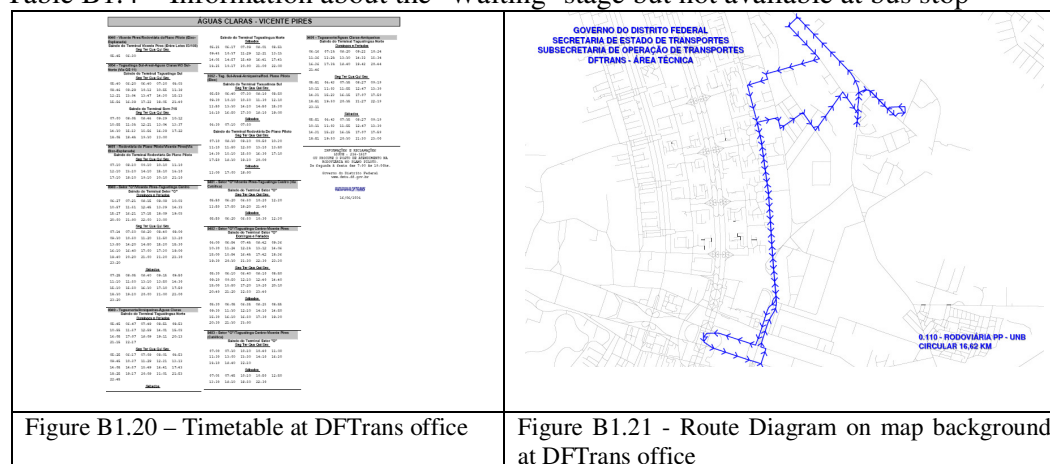
Photos were taken by the researcher.

Table B1.3 – Information in the ‘Waiting’ stage (bus stop, Plano Piloto, North Wing)



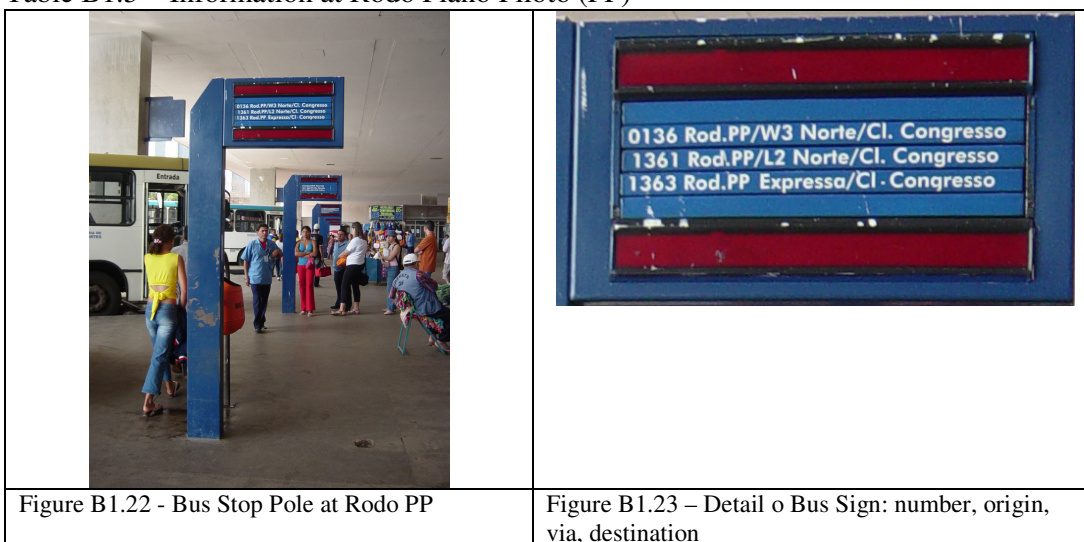
Photos were taken by the researcher.

Table B1.4 – Information about the ‘Waiting’ stage but not available at bus stop



Source: DFTRANS

Table B1.5 – Information at Rodo Plano Piloto (PP)



Photos were taken by the researcher.

Table B1.6 – Information in the ‘Riding’ Stage (inside a bus, only the conductor and the driver can provide information)



Figure B1.24 – Inside a bus

Photo was taken by the researcher.

Table B1.7 – Orientation System



Figure B1.25 – Orientation sign for Hospital Sarah, customized for drivers

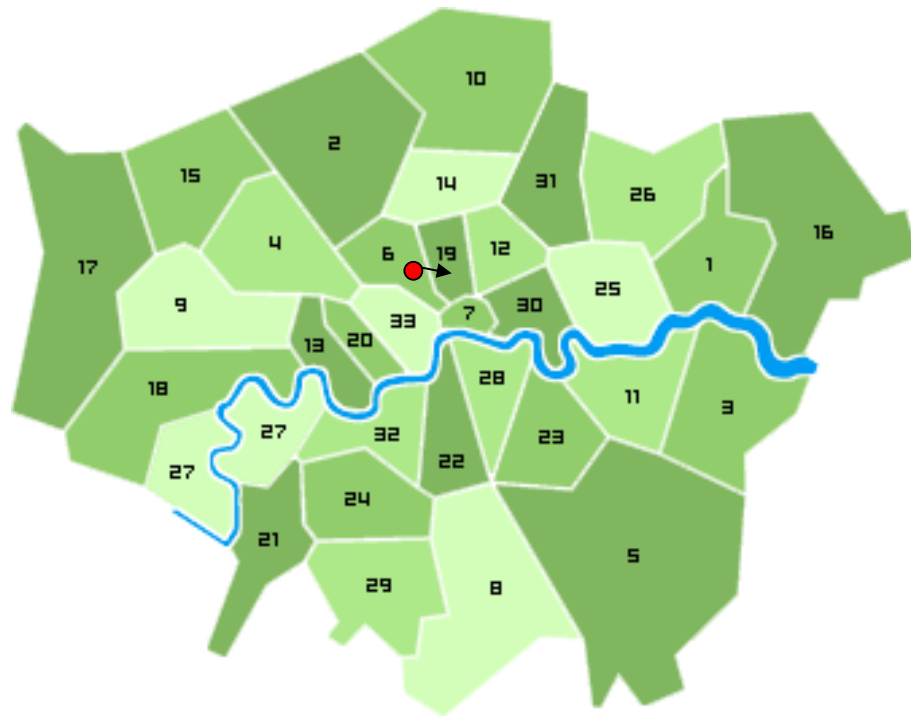
Photo was taken by the researcher.

ANNEXE A.2

INFOCHAIN ACCESSIBILITY INFORMATION TYPE

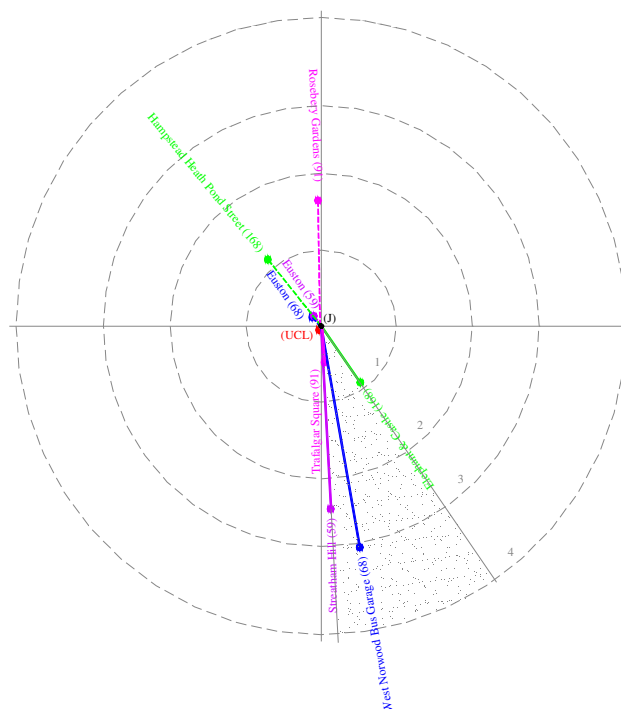
Table A2.1 – INFOChain Accessibility Type of Information Presented to Participant

Information # 1) Macro reference map: Direction of the journey on a big scale map focusing limits of boroughs and satellites cities. Provide a high level knowledge



Information # 2) Radial Mobility: Cardinal disposition of bus stop and bus services direction

RADIAL MOBILITY - BUS STOP (J): Russel Square



Information #3) Picture sequence of the path with directions Sequence of pictures taken at the site

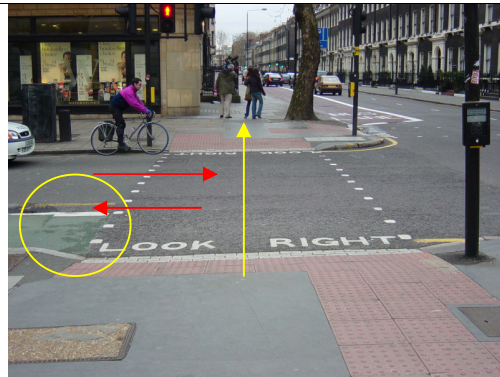
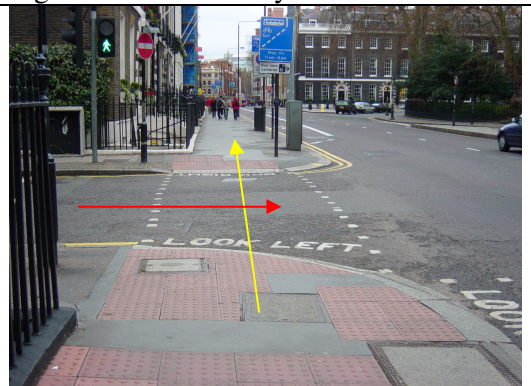
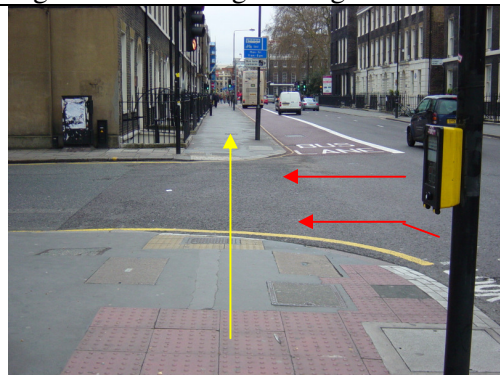


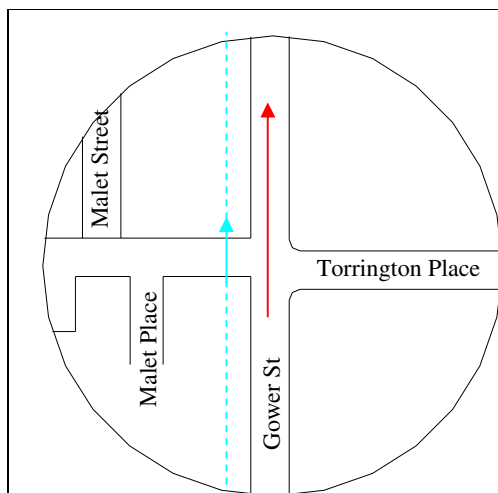
Figure 1 – Crossing Torrington Place



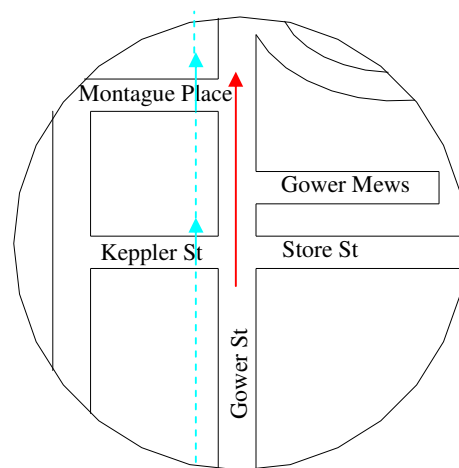
Figure 2 – Detail of Cycle Lane



Information # 4) Drawing Sequence of the path Micro scales of streets and crossing point along the path to and from bus stops



Graph 1 – Crossing Torrington Place



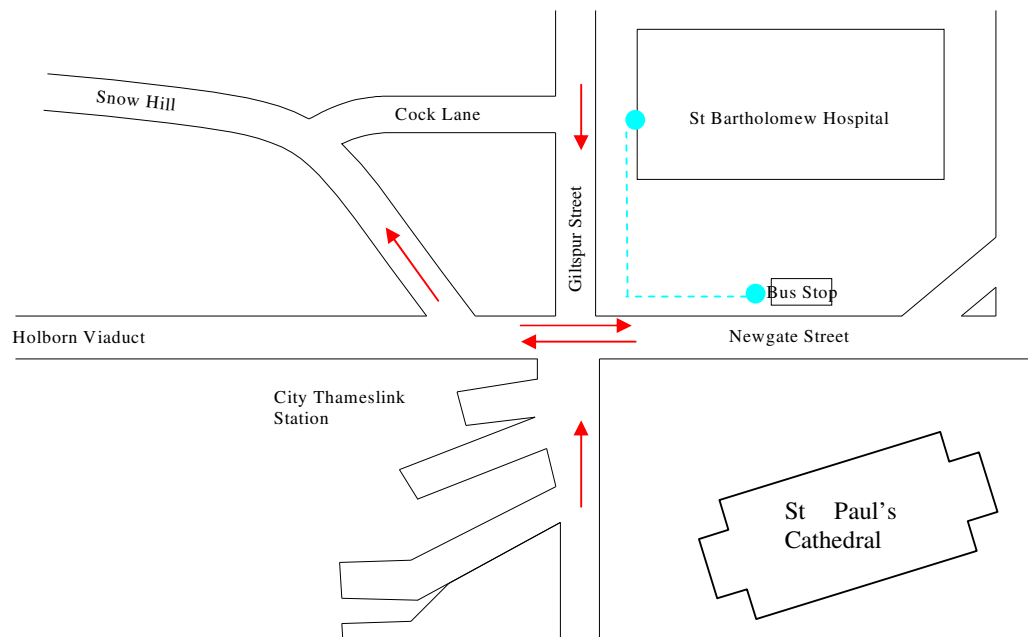
Graph 2 – Crossing St Keppel Street and Montague Place

Information # 5) Detailed description of pat: the barriers found in the walking path (to and from bus stops).

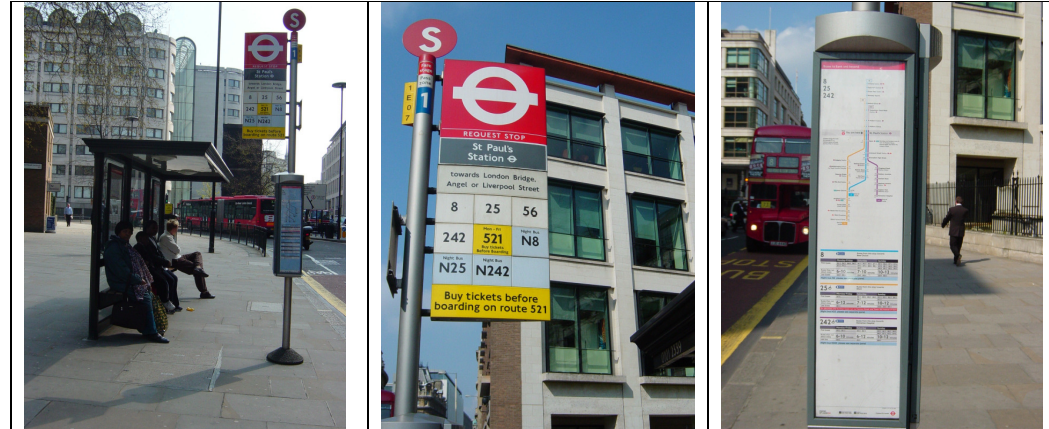
“ ... The only street with traffic signal is Torrington Place. The others are formalised but pedestrian have to pay attention on the direction the vehicles are coming from. St. Keppel Street, for example.

The area is characterised as a mixed one - commercial and residential. The total walking distance is 1100m or 15 minutes. The pavers are in reasonable condition and all crossfall are under 2.5%. The footways width varies a lot from 2.8m to 1.0m. The flow of pedestrian from Great Russell Corner to Bust Stop point is intense due the tourist attraction of the area (The British Museum).”

Information # 6) Complete drawing map of the path to and from bus stops.



Information # 7) Pictures and Information at bus stop area: bus stop layouts and information available



Information #8) Accessibility evaluation of bus stop platform: Textual description of accessibility conditions at bus stop site

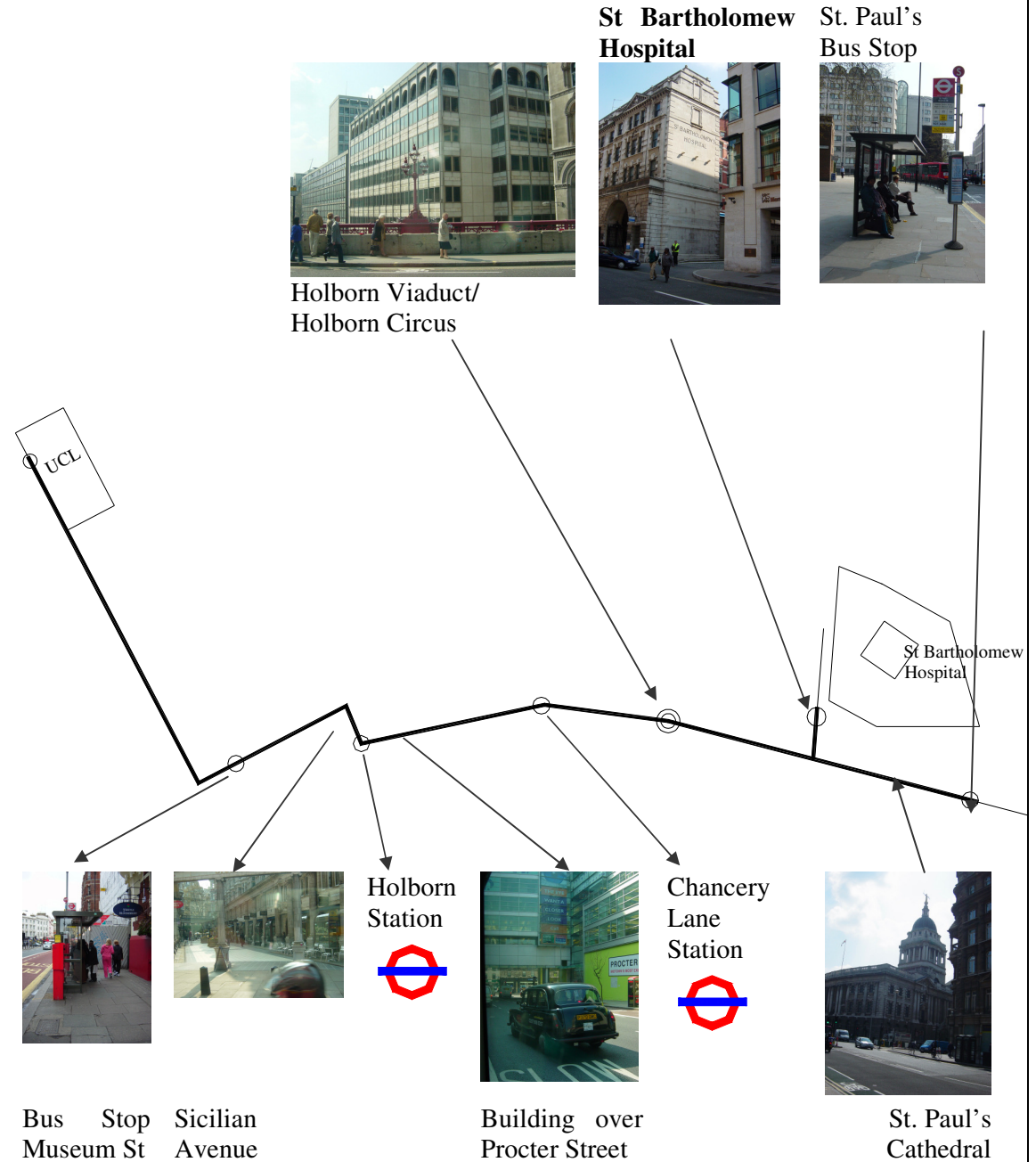
“ Table 3 illustrates the bus stop (WB) environment. It has a L-Type shelter facing the wall (not the street), lights, but no seats. According accessibility issues the shelter should face the street, but it was installed in the wrong way due to the lack of space at the area. The footway is 4.0m wide. The area available to access vehicle is restricted by bus pole and the ticket machine. The conclusion is that the space available is not enough to accommodate a bus stop, special one that serves 9 lines. The proper way to accommodate a bus stop at the area is to build a border (1 m or 2 m out on the street). More features at this stop can be seen in Table 3.”

Information # 9) Location of the nearest accessible bus stop: Nomination and distance of the nearest accessible bus stop

Information #10) Pictures of Gaps examples Picture of parked bus at bus stop sites



Information #11: Schematic route with landmarks from UCL to St. Bartholomew



Information #12: Detail description of riding: Textual description of itinerary.

“...The riding takes approximately 8 minutes in a Double Decker type bus. Figure 22 illustrates the interior of the vehicle. The vehicle is said to be accessible with 1 formal space for wheelchair user but there is no kind of information inside the vehicle except the “Stopping Sign”. Tariff: £ 1.20 to get to your final destination, if you don’t have season cards. The ticket has to be bought in advance at the ticket machine, next to the shelter. Pictures of the main landmarks along the journey are shown in the schematic route figure.”

ANNEXE A.3

PARTICIPANTS' REPRESENTATION INFOCHAIN OUTPUTS

4.1. Please do a representation of London in the space below.

4.2. Please do a representation of London showing the principal ways of movement, try to represent every possible way you can remember. You can use the previous representation or do another from scratch.

Test 2

2.1. Please do a representation of London in the space below. The City of London is there for reference.

Test 2

2.1. Please do a representation of London in the space below. The City of London is there for reference.

Test 2

2.1. Please do a representation of London in the space below. The City of London is there for reference.

2.2. Please do a representation of London showing the principal ways of movement, try to represent every possible way you can remember. You can use the previous representation or do another from scratch.

Table A3.2 – Participants' Representation of Brasília: City and Movement

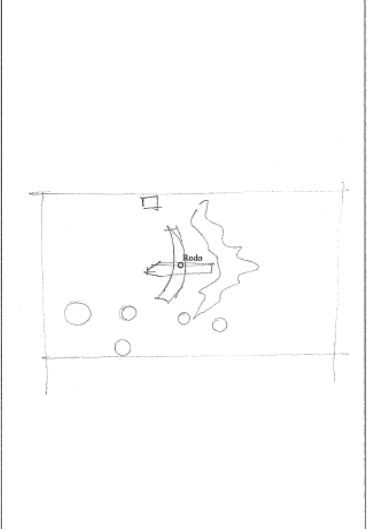
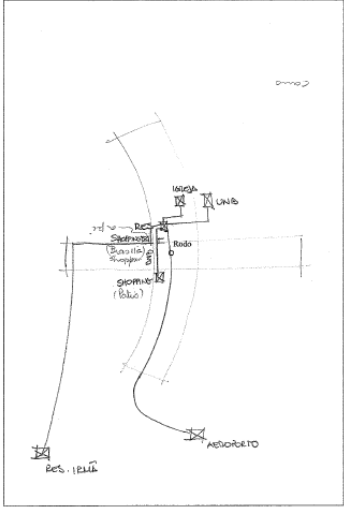
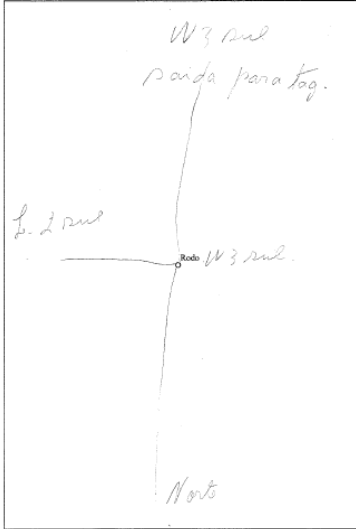
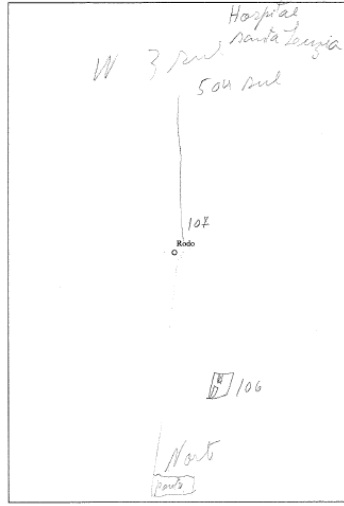
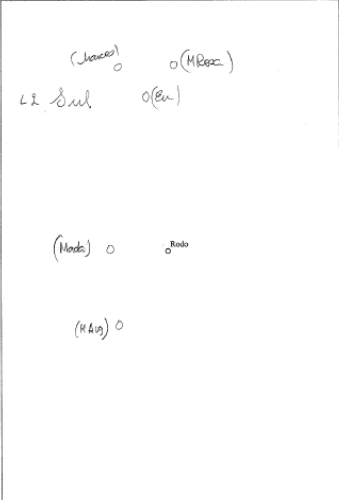
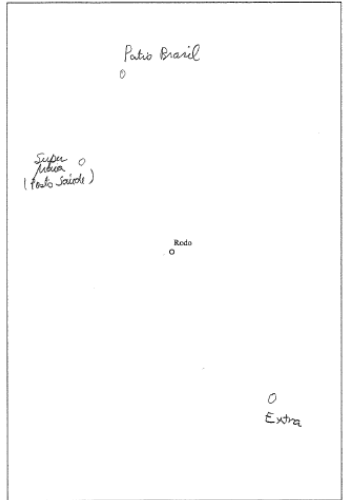
<p>2.1. Por favor faça uma representação de Brasília no espaço abaixo. "Rodo" representa a Rodoviária do Plano Piloto.</p> 	<p>2.2. Por favor faça uma representação de Brasília mostrando as principais mancinha pelas quais você se movimenta pela cidade, tente lembrar diferentes maneiras de movimento/locomção.</p> 
<p>2.1. Por favor faça uma representação de Brasília no espaço abaixo. "Rodo" representa a Rodoviária do Plano Piloto.</p> 	<p>2.2. Por favor faça uma representação de Brasília mostrando as principais mancinha pelas quais você se movimenta pela cidade, tente lembrar diferentes maneiras de movimento/locomção.</p> 
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Table A3.3 – INFOChain-UK: Male 01: Evolution of Journey Representations during the Experiment

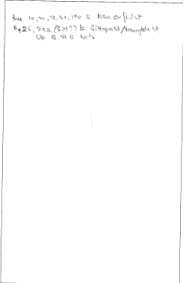
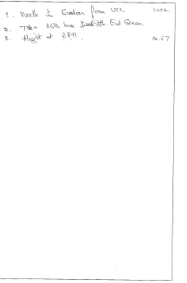
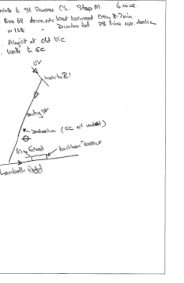
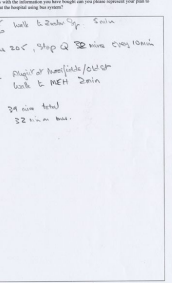
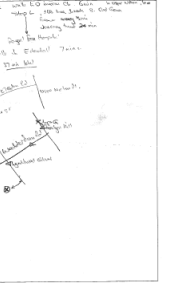
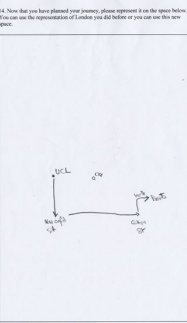
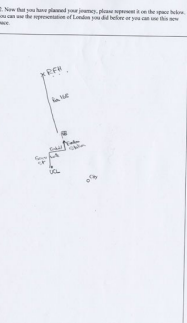
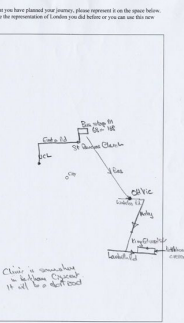
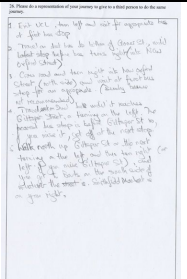
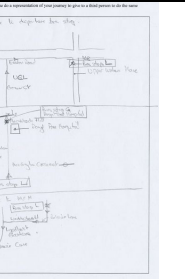
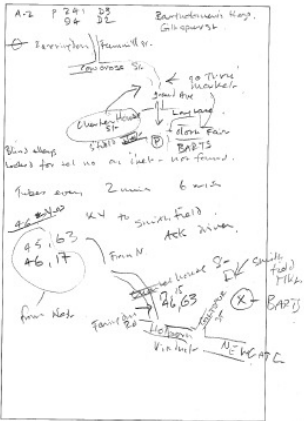
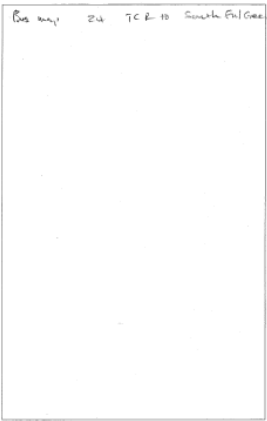
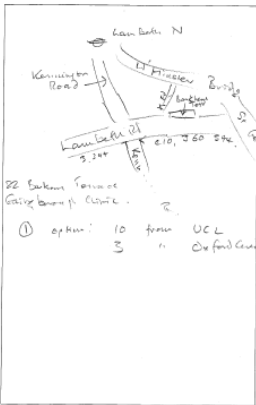
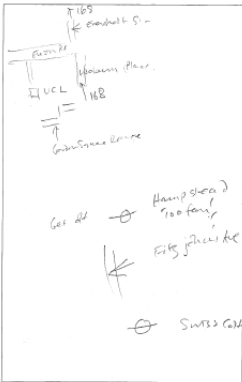
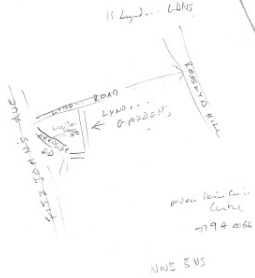
BASELINE 1	TREATMENT 1	TREATMENT 2	TREATMENT 3	BASELINE 2
PLAN				
				
REPRESENTATION Before Journey				
			Not Applicable	
REPRESENTATION After Journey				
	Not Applicable			

Table A3.4 – INFOChain-UK: Male 02: Evolution of Journey Representations during the Experiment

BASELINE 1		TREATMENT 1	TREATMENT 2	TREATMENT 3	BASELINE 2
PLAN					
<div><p>11. How did you plan your journey?</p><p>After the 1st day of the journey, I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. I was told to go to the treatment center. 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Table A3.5 – INFOChain-UK: Female 01: Evolution of Journey Representations during the Experiment

BASELINE 1	TREATMENT 1	TREATMENT 2	TREATMENT 3	BASELINE 2
PLAN				
				 

Continuing Table A3.5 – INFOChain-UK: Female 01: Evolution of Journey Representations during the Experiment

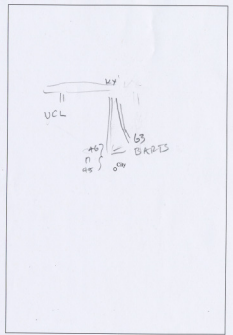
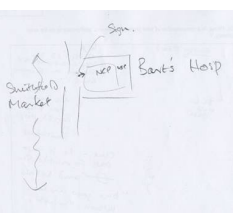
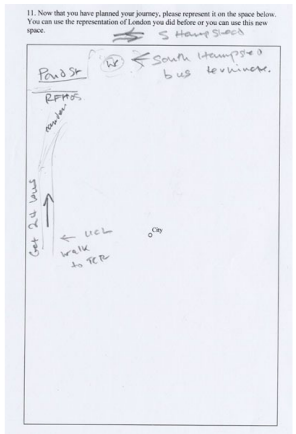
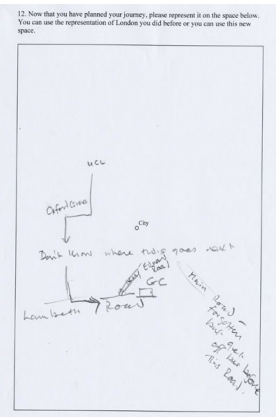
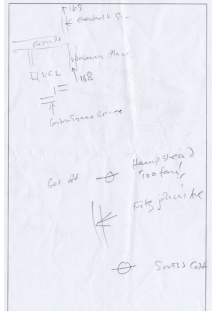
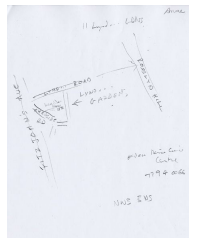
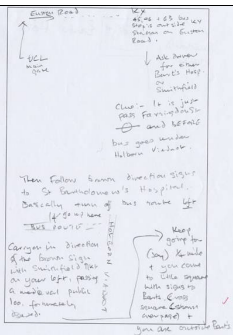
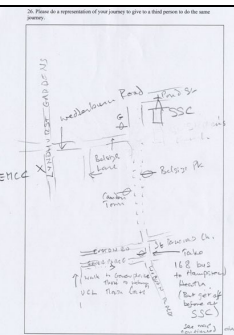
REPRESENTATION Before Journey				
<div></div> <div></div>	<div>11. Now that you have planned your journey, please represent it on the space below. You can use the representation of London you did before or you can use this new space.</div> <div></div>	<div>12. Now that you have planned your journey, please represent it on the space below. You can use the representation of London you did before or you can use this new space.</div> <div></div>	<div>Not Applicable</div>	<div></div> <div></div>
REPRESENTATION After Journey				
<div></div>	<div>Not Applicable</div>	<div></div>		

Table A3.6 – INFOChain-BR: Female 01: Evolution of Journey Representations during the Experiment

Table A5.5: IN-Session DX: Female 01: Evolution of Journey Representations during the Experiment				
BASELINE 1	TREATMENT 1	TREATMENT 2	TREATMENT 3	BASELINE 2
PLAN				
<p>PREANALISE - HEMODIALISE</p> <p>08:00 - 10:00</p> <p>44-45 SEPTEMBRE / 42 / HEMODIALISE PP</p> <p>(POURTE) 08:00 08:00 (44)</p> <p>08-10-7</p>	<p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p>	<p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p>	<p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p>	<p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p> <p>08:00 - 10:00 08:00</p>
REPRESENTATION Before Journey				
<p>10. Agente que veut planifier son périple, par force, son a repère d'attente pour attendre la</p>	<p>11. Agente que veut planifier son périple, par force, son a repère d'attente pour attendre la</p>	<p>12. Agente que veut planifier son périple, par force, son a repère d'attente pour attendre la</p>	Not Applicable	<p>13. Agente que veut planifier son périple, par force, son a repère d'attente pour attendre la</p>
REPRESENTATION After Journey				
<p>14. Agente que veut planifier son périple, par force, son a repère d'attente pour attendre la</p>	Not Applicable		<p>15. Agente que veut planifier son périple, par force, son a repère d'attente pour attendre la</p>	

BASELINE 1		TREATMENT 1	TREATMENT 2	TREATMENT 3	BASELINE 2
PLAN					
REPRESENTATION Before Journey					
			Not applicable		
REPRESENTATION After Journey					
	Not Applicable				

Table A3.8 – INFOChain-BR: Female 03: Evolution of Journey Representations during the Experiment

BASELINE 1	TREATMENT 1	TREATMENT 2	TREATMENT 3	BASELINE 2
PLAN				
REPRESENTATION Before Journey				
			Not Applicable	
REPRESENTATION After Journey				
		Not Applicable		

ANNEXE A.4 GLOSSARY OF TERMS

This glossary brings definitions of terms as they are used in this thesis, particularly those related to psychology and neuropsychology areas. Terms that appear in italics in the definitions have their own entries in this glossary.

Ability	The quality or state of being able; power to perform, whether physical, moral, intellectual or legal; skill or <i>competence</i> in doing.
Allocentric	Allocentric <i>Frame of Reference</i> : relative to one own bodies
Agnosia	Severe deficit in the <i>ability</i> to perceive sensory information, usually related to the visual sensory modality; agnosics have normal sensations but lack the <i>ability</i> to interpreted and recognise what they sense, usually as a result of lesions in the brain. Sternberg (1999).
Attention	Process of seeking out stimulus that are of interest. Goldstein (1999) The cognition link between the limited amount of information that is actually manipulated manually and the enormous amount of information available through the senses, stored memories and other <i>cognitive processes</i> . Sternberg (1999).
Behaviourism	A school of psychological thought that focuses entirely on the links between observed stimuli and observed process, discounting any mental phenomena that cannot be observed directly. Sternberg (1999).
Battery tests	A series of brief different tests used to test individual's potential for a specific knowledge domain. The standard battery of cognitive tests in The INFOChain system includes immediate/delayed word recall, word recognition, picture recognition, simple reaction time, choice reaction time, numeric working memory, and spatial working memory.
Capability	Set of skills to complete an activity.
Cognitive load	Cognitive load is a term that refers to the load on working memory during instruction.
Cognitive map	The human <i>ability</i> to find the way in an environment. Lynch (1960) uses it as the extent of individual's knowledge of an environment.
Cognitive process	The process of thought.
Cognitive psychology	Study of the way the brain process information. It includes the mental processes involved in <i>perception</i> , learning, memory storage, thinking and language.
Competence	The state or quality of being adequately or well qualified, having the <i>ability</i> to perform a specific role.
Computer modelling	Simulation of human cognitive processes by computer.
Consciousness	The complex phenomenon of evaluating the environment and then filtering that information through the mind, with awareness of doing so. Sternberg (1999).
Construct	Ideas to help summarize a group of related phenomena or

	objects.
Declarative knowledge	Descriptive knowledge, also declarative knowledge or propositional knowledge: consists of isolated shots of objects, functions as a landmark reference with meaning and significance attached.
Dependency	Extent to which a person needs help from others to maintain a normal life. Bowling (2005).
Disability	Inability to perform tasks and functions in a normal manner. Bowling (2005).
Distal stimulus	Stimulus in the environment, usually at a distance from the observer. Goldstein (1999).
Episodic memory	Memory for specific episodes and events from personal experience, occurring in particular context of time and place.
Encoding	Process by which a physical, sensory input is transformed into a representation that can be stored in <i>memory</i> . Sternberg (1999).
Frame of reference	A coordinate system or set of axes within which to measure the position, orientation, and other properties of objects in it, or it may refer to an observational reference frame tied to the state of motion of an observer.
Galileo positioning system	The European Union and European Space Agency own alternative to GPS. The system is scheduled to be working from 2012.
GIS (Geographical Information System)	The spatial element of environmental information promotes the use of geographical information..
GPS (Global Positioning System)	The United States' Global Positioning System (GPS), which as of 2007 is the only fully functional, fully available global navigation satellite system.
Haptic system	"The sensibility of the individual to the world adjacent to his body by use of his body". Gibson (1966).
Heuristics	Methods or strategies, which often lead to a problem solution but are not guaranteed to succeed.
Hierarchical Organization	Hierarchical organization suggests that small parts of the whole hierarchical array depend, for their meaning, on their membership in larger parts.
Information processing	Information processing in cognitive science is the manipulation of symbols according to a set of rules embodied in a program.
Landmark knowledge	Represents information about the shape, size, color, and contextual information of landmarks, or memorable and distinctive objects in an environment.
Long Term Memory	Memory that can last as little as a few days or as long as decades.
Memory	The means by which individuals draw on past knowledge in order to use such knowledge in the present; the dynamic mechanisms associated with the retention and the <i>retrieval</i> of information. Sternberg (1999).
Metacognition	The <i>ability</i> of an individual to think about and to consider carefully the person's own process of thought; particularly in regard to trying to strengthen cognitive abilities. Sternberg (1999).
Navigation	Consists of both wayfinding and motion.
Neural processing	Operation that transform electrical signals in the network of neurons. Goldstein (1999).

Neurocognitive	A term used to describe cognitive functions closely linked to the function of particular areas, neural pathways, or cortical networks in the brain.
Neuropsychology	The basic scientific discipline that studies the structure and function of the brain related to specific psychological processes and overt behaviors. The term neuropsychology has been applied to lesion studies in humans and animals and how brain damages affect behaviour. It has also been applied to efforts to record electrical activity from individual cells (or groups of cells) in higher primates (including some studies of human patients).
Perception	Set of processes which people recognise, organise, synthesise and give meaning (in the brain) to the sensation received from environmental stimuli (sense organs). Sternberg (1999).
Perceptual process	Behavioural approach: focus in relationship between the physical properties of stimuli and the perceptual response (Goldstein, 1999). Phenomenological approach: ask individual to describe what they perceive (Goldstein, 1999). stimulus- <i>perception</i> relationship: the physical stimulus and what a person perceives. (Behavioural approach) (Goldstein, 1999). stimulus-physiology relationship: connections between stimulus and nerve firing (Physiological approach) (Goldstein, 1999). physiology- <i>perception</i> relationship: how the inner work of the brain result in <i>perception</i> (combination of approaches) (Goldstein, 1999).
Perceptual processing	Mental or neural processing that occurs during the process of <i>perception</i> . Goldstein (1999).
Problem solving	Higher-order cognitive process that requires the modulation and control of more routine or fundamental skills. Goldstein & Levin (1987). A process for which the goal is to overcome obstacles obstructing a path to a solution. Sternberg (1999).
Procedural knowledge	The knowledge exercised in the performance of some task. Also referred to as route knowledge, is encoded as a series of navigational steps required in following a particular route.
Proximal stimulus	Stimulus that stimulates person's visual receptors. The internal sensation of a source of stimulation, as it is registered by the sensory receptors. Sternberg (1999).
Rational choices	Assumes that people have goals and they act in order to maximize their goals. Jones (2001).
Recognition	<i>Ability</i> to place an object in a category that gives it meaning. Goldstein (1999).
Rehearsal	Strategy for keeping information in short term or for moving information into long term by repeating the information over and over, usually by elaborating the information in some way. Sternberg (1999).
Retrieval	Recovery of stored information from <i>memory</i> , by moving the information into <i>consciousness</i> for use in active <i>cognitive processing</i> . Sternberg (1999).
Satellite Navigation Systems	Systems that provide autonomous geo-spatial positioning with global coverage.

Schema	A cognitive framework for meaningfully organising various interrelated concepts, based on previous experiences. Sternberg (1999).
Selective attention	<i>Ability</i> to attend to one out of many competing streams of information or to attend to a subset of information within a single stream.
Semantic memory	Knowledge about the external world, such as the function
Sensory information	Information processed by the sensory system (part of the nervous system: vision, hearing, somatic sensation (touch), taste and olfaction (smell).
Short-term memory.	Short-term memory (sometimes referred to as "primary memory" or "active memory") refers to the capacity for holding a small amount of information in mind in an active, readily available state for a short period of time.
Spatial knowledge	Landmark knowledge, procedural knowledge, and survey <i>knowledge</i> , are collectively referred to as spatial knowledge (Thorndyke and Goldin, 1983; Thorndyke and Hayes-Roth, 1982; Thorndyke and Stasz, 1980).
Survey knowledge	Provides a “bird’s eye view” of a region in which object locations and inter-object distances are encoded in terms of a geocentric (i.e. global) <i>frame of reference</i> .
Synapse	A small space between the end of one neuron to the cell body of another neuron. Goldstein (1999).
Stereopsis	Process in visual <i>perception</i> leading to the sensation of depth from the two slightly different projections of the world onto the retinas of the two eyes.
Telematics:	Application of information and communications technology to transport problems.
Transduction	Transformation of one form of energy into another form of energy.
Virtual environments (VEs)	Provide a computer-synthesized world in which users can interact with objects and perform various activities.
Virtual reality	Technology which allows a user to interact with a computer-simulated environment (simulation of the real world or an imaginary world).
Wayfinding	The act of traveling to a destination by a continuous, recursive process of making route-choices whilst evaluating previous spatial decisions against constant cognition of the environment. (Conroy, 2001).
Wayfinding skills	Any strategy that can make spatial task easier, e.g.: use part-whole; straighten edges, put things closer to landmarks, priming semantic relations.
Working memory	A portion of memory that may be viewed as a specialised part of the memory; it holds only the most recently activated portion of long term memory and moves these activated elements into and out of short-term memory. Sternberg (1999).

The terms with no formal reference are based on the definition suggested by Wikipedia Project: a web-based, collaborative, encyclopedia project (<http://en.wikipedia.org>).